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THESIS

THE EFFECT OF STEM DEGREES ON THE PERFORMANCE AND RETENTION OF JUNIOR OFFICERS IN THE U.S. NAVY

by

William V. Maugeri III

March 2016

Thesis Advisor: Simona Tick
Co-Advisor: Stephen Mehay

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THE EFFECT OF STEM DEGREES ON THE PERFORMANCE AND RETENTION OF JUNIOR OFFICERS IN THE U.S. NAVY

William V. Maugeri III
Lieutenant, United States Navy
B.S., United States Naval Academy, 2008

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March 2016

Approved by: Simona Tick
Thesis Advisor

Stephen Mehay
Co-Advisor

Bill Hatch
Academic Associate
Graduate School of Business and Public Policy

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The Navy has long operated under the “Rickover hypothesis,” stressing the importance of recruiting and retaining Science Technology Mathematics and Engineering (STEM) background officers to man the increasingly technologically advanced weapon systems. This thesis tests the validity of this hypothesis by analyzing the performance and retention of junior officers with STEM degrees, compared with that of junior officers with non-STEM degrees. Additionally, this thesis examines the effects of college selectivity, commissioning source and various demographics on performance and retention. While previous research on the effects of STEM degrees on junior officer performance and retention have been largely inconclusive, this thesis’s findings show that a STEM degree has positive and significant effects on retention and on promotion to O-4, and a negative effect on Fitness Report performance. Further research can be done to examine which STEM majors are most likely to succeed, and how lateral transfer opportunities impact STEM officer performance and retention.

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LIST OF ACRONYMS AND ABBREVIATIONS

BUPERS	Bureau of Naval Personnel
DMDC	Defense Manpower Data Center
EP	Early Promotion
FITREP	Fitness Report
FY	Fiscal Year
GPA	Grade Point Average
JO	Junior Officer
MSR	Minimum Service Requirement
NPS	Navy Personnel Command
NROTC	Naval Reserve Officers Training Corps
OCS	Officer Candidate School
RAP	Recommendation for Early Promotion
RL	Restricted Line
STEM	Science, Technology, Engineering, Mathematics
SUB	Submariner Officer
SWO	Surface Warfare Officer
URL	Unrestricted Line
USNA	United States Naval Academy

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I. INTRODUCTION

The importance of commissioning and retaining Navy officers with Science, Technology, Engineering, and Science (STEM) backgrounds was a steadfast belief held by the father of the nuclear navy, Admiral Hyman Rickover (Bowman 1990, 271–286). His belief was forcefully endorsed in testimony before Congress in 1976, giving birth to the “Rickover hypothesis” (Bowman 1990). The authoritative and historical significance of the Rickover hypothesis has reverberated throughout the U.S. Navy and has carried over into the current climate that demands a highly skilled and diverse workforce.

The Navy has continued to push the introduction of new technology in the fleet. The optimization of manpower combined with the new technology has amplified the need for technically trained personnel. Furthermore, the increased training requirements necessary for the proper management of a more technologically advanced fleet has put pressure on the officer-training pipeline. The idea of college graduates arriving to the fleet with technologically oriented backgrounds through STEM degrees is attractive. One of the key assumptions of the Rickover hypothesis is that officers with STEM-oriented backgrounds will require less training and will be more effective Navy officers.

While the Rickover hypothesis has not been conclusively validated by prior empirical findings, the Navy continues to implement policies based on its presumed efficacy. The Navy has recently promoted the idea of talent management in an attempt to improve the utilization of service member’s educational backgrounds. As the Navy continues to advance technologically, the belief that more technically trained officers are more effective has prevailed despite limited and inconclusive empirical results to date. In order to optimize Navy recruiting and educational policies, the hypothesis that technically trained officers are superior performers to non-technically trained officers needs to be empirically tested.

This thesis takes a quantitative approach to comparing the job performance of junior officers with STEM backgrounds to that of non-STEM background officers in the U.S. Navy. Using multivariate statistical techniques, the study examines STEM educational background effects on performance, by community, for the population of Navy officers commissioned between FY1999 and FY2003. The study carefully analyzes the factors that are most likely to explain observed outcomes in retention, performance, and promotion of Navy officers and to compare these outcomes between STEM and non-STEM officers. The findings of this thesis bring insights into the job performance of STEM background officers relative to their non-STEM peers, and their importance in the current and future manning requirements of the U.S. Navy.

The rest of the thesis is organized as follows: Chapter II presents a Background, Chapter III reviews the most relevant prior studies on the STEM officers' performance in the Navy, Chapter IV presents the Data used in this study, Chapter V presents the multivariate regression analysis methodology and results, while Chapter VI concludes and formulates recommendations.

II. BACKGROUND

The U.S. Navy strives to manage talent by recruiting, developing, and retaining a high-quality, diverse workforce that meets the requirements of current and forecasted billets and weapons platforms. In addition, the U.S. Navy is an organization dedicated to maintaining technological superiority over potential foes. A major component of technical superiority is the human capital of the people maintaining and fighting various naval platforms. Human capital consists of the education, training, and experience of individuals in the work force (Schultz 1951). An important aspect of human capital is not only its attainment but also the type and quality of human capital (Schultz 1951, 1). In order to maximize its operational capabilities, the Navy has placed a renewed effort on increasing the number of STEM junior officers within its ranks (Office of Naval Research 2011). A STEM officer is one who graduated with an undergraduate degree in science, technology, engineering, or mathematics. The human capital accumulated by STEM officers through their undergraduate education, in theory, provides them with a unique advantage as naval officers in comparison to their non-STEM peers. The U.S. Navy seeks to capitalize on the inherent technical skills and knowledge possessed by STEM officers.

A. POLICY INFLUENCE

The Navy's emphasis on commissioning officers with a background in STEM can be seen in how commissioning sources such as the U.S. Naval Academy and NROTC require their students to major in STEM. The U.S. Naval Academy's academic website advertises:

> For the Naval Academy Class of 2013 and beyond, at least 65% of those graduates commissioned into the U.S. Navy must complete academic majors in science, technology, engineering, or mathematics disciplines. This institutional requirement applies as well to NROTC programs at other colleges. (USNA, 2015)

Moreover, USNA students are required to take core classes that include physics, chemistry, calculus and various engineering courses. This actually provides all USNA commissioned officers with a background in core science and mathematics subjects.

Furthermore, the Navy's focus on increasing STEM education within the Navy officer community can be seen in various STEM community outreach programs. For example, the U.S. Naval Academy STEM Center for Education and Outreach's mission emphasizes the need for officers with STEM backgrounds. "The USNA STEM Center is focused on addressing an urgent national need for more young people to pursue careers in science, technology, engineering and mathematics" (USNA STEM Center 2015). Not only does the USNA STEM Center reinforce the Navy's preference to STEM officers but it also provides a recruiting tool for the Navy to encourage perspective Midshipmen to consider the Naval Academy, and a Naval career, as viable future options. In addition to the Naval Academy's STEM outreach program, the Navy maintains a U.S. Navy STEM Facebook page used to advertise the STEM opportunities within the Navy to perspective officers and enlistees alike.

Commissioning sources like the U.S. Naval Academy and NROTC predominantly commission Unrestricted Line (URL) officers such as Surface Warfare Officers and Submarine Officers who encountered an increasingly technologically advanced Navy. The emphasis on commissioning officers with a background in STEM directly supports their mission in preparing URL officers for the fleet.

The demand for technical training would appear to have increased with the introduction of a new generation of ships that are more capital-intensive and less labor-intensive. The assumption is that, a junior officer with a STEM degree would arrive at a ship or submarine with the technical background and specific skills to provide them with early career success. An officer with a STEM degree could be potentially more receptive to technical training and, therefore, more likely to attain a warfare qualification. Moreover, their technical human capital would make them agile enough to be successful in follow-on tours on different Navy platforms.

The presumed advantage of STEM junior officers is that they will perform better than other officers in an increasingly technical environment. However, the hypothesized advantage of STEM junior officers has not been extensively tested. The responsibilities of a junior officer go beyond technical familiarity and require substantial interpersonal skills and leadership qualities. These intangible skills, often called "soft" skills, may be more likely to be acquired in non-STEM majors (e.g., humanities and social sciences). However, officer-commissioning programs such as OCS and NROTC are designed to provide all officer candidates with the basic skills and abilities necessary for success as a junior officer. The hypothesis that junior officers with STEM degrees are superior performers implies that the interpersonal or ‘soft’ skills required of a junior officer are more easily acquired than are the technical skills needed in the Navy. The technical skills associated with a STEM degree are obtained over the course of their undergraduate educational experience. On the other hand, the interpersonal skills that supplement their technical abilities are taught during their three- to six-month indoctrination period.

Previous studies of naval officers have focused mainly on officer retention and the effects of different college majors. This study specifically examines differences in both the performance and retention for junior officers with and without STEM majors. For the purpose of this thesis, job performance is also measured by using officer fitness reports (FITREPs). Recent efforts in officer recruitment have focused on increasing the number of newly commissioned officers with technical degrees. The findings of this thesis will help guide Navy policy in recruiting officers with academic backgrounds most suitable for junior officer responsibilities.

Any highly skilled workforce continually faces the challenge of retention. A robust civilian labor market for college-educated technical workers threatens the U.S. Navy’s goal of retaining an officer corps with a high percentage of STEM officers. The U.S. Department of Commerce notes that careers in STEM fields offer high pay and room for job growth even if the individual does not work in a STEM-related field (U.S. Department of Commerce 2011). The challenge of retention becomes readily apparent very early in a Junior Officer’s career as they are required to serve four to five years based on their commissioning source. Upon realizing their obligated service, junior officers have the choice of leaving the Navy, lateral transferring to a different community, or continuing their career. Certain communities must offer substantial retention bonuses in order to retain high quality officers who are attracted to good civilian labor market opportunities.

B. SCOPE OF THESIS

While this thesis examines all officer communities in the Navy, it focuses on the surface and subsurface communities. The surface and subsurface communities are where STEM officers are most likely to apply their technical knowledge and skills and where the Rickover hypothesis is more likely to be applicable. The completion of a warfare qualification is mandatory for most Unrestricted Line (URL) communities. One hypothesized advantage of a STEM background is that junior officers with these degrees are more likely to complete qualifications required in their community. The completion of a warfare qualification is a signal that an officer is competent enough to progress in their career. Additionally, by examining the effects of STEM degrees by community, it may allow junior officers the opportunity to employ their STEM degrees and provide a higher level of job satisfaction as well as increase their opportunities to pursue technical graduate education.

This thesis compares job performance and retention outcomes of junior officers with STEM degrees to the outcomes from junior officers without STEM degrees. This thesis also analyzes the retention and promotion outcomes associated with other important officer characteristics, such as college quality, commissioning source, community, and demographic background. The study attempts to measure the importance of STEM degrees to the career success of junior officers in the U.S. Navy.

Moreover, this thesis examines how college major and college quality affect junior officer performance across all designators. This provides insight into not only the importance of STEM degrees but also the interaction between college major and college quality. Not all STEM degrees are created equal and not all STEM officers are equally proficient in their fields. Furthermore, not all STEM degrees are utilized to the same extent across all jobs and all warfare communities.

As previously mentioned, a major focus of this thesis is the examination of the retention of junior officers with and without STEM degrees. This thesis evaluates other factors that affect retention such as job fit. The high demand for STEM graduates in the civilian labor market is considered when analyzing the retention of STEM Navy officers beyond their minimum service obligations (MSR). An additional retention factor to be considered is lateral transfers within officer communities. Many officers lateral transfer from one community to another, typically from an operational (URL) community to a staff community.

In support of a high quality, diverse workforce, this thesis also analyzes the promotion to O-4 of STEM junior officers against non-STEM junior officers by demographic groups. While the Navy is focused on a technically trained officer corps, it still maintains a priority to have that workforce be diverse and representative of the nation. These goals are especially important in senior leadership positions. Previous research has examined officer performance at a time when the proportion of female officers was significantly lower than it is today. Not only has the population of female officers increased in recent decades but the number of females attending college and attaining technical degrees also has increased somewhat markedly. The percentage of female commissioned officers rose from 4 percent to 16 percent between 1973 and 2011 (Patten and Parker 2011). Moreover, according to the National Science Foundation, between 1993 and 2010 “the proportion of workers with a highest degree in an S&E field who are women” increased from 31 percent to 37 percent (National Science Foundation, Science and Engineering Indicators 2014). An important component of this thesis is the relationship between gender and college background.

Finally, commissioning sources of STEM officers are examined to determine their effects on officer job performance and retention. Previous research has provided inconclusive results on the effects of commissioning sources. Examining the effect of commissioning source will help in analyzing differences in the effects of STEM officers depending on commissioning program. For example, all graduates of the U.S. Naval Academy, regardless of major, are required to take core courses that include introductory engineering courses, physics, chemistry, and mathematics. Thus, they all receive some technical knowledge and skills.

An important consideration in examining the effects of STEM degrees on junior officers is how STEM is defined. In the traditional sense, STEM is a very broad term that includes numerous majors that may not have any relevance to the technical skills required of a Navy officer. This thesis attempts to create a more Navy-specific definition of STEM and investigate its effects compared to the broad STEM definition. By narrowing the STEM definition and tailoring it to be more Navy-focused, a more nuanced approach can be taken by the Navy to identify degrees and programs that provide the skills and knowledge needed in an increasingly technical occupation. While STEM majors such as botany and zoology are signals of high-level intelligence, they are not necessarily indicators of acquired Navy-related human capital.

C. PURPOSE

The Navy's rapid advancements in technology combined with an increased demand for STEM degrees in the civilian labor market has brought renewed attention to the hypothesis that STEM officers are critical in support of a highly skilled officer corps. It is crucial for the Navy to remain a lucrative option for junior officers with STEM degrees while ensuring their technical backgrounds are efficiently utilized. This study provides insight into the factors that affect the retention of STEM junior officers and how their job performance compares to non-STEM officers.

This thesis is of importance to the U.S. Navy because it provides insight into the credibility of the Rickover hypothesis that assumes officers with a technical degree are superior to Navy officers without such degrees. The Navy has operated under and developed policies based on an unproven hypothesis that has seldom been investigated. This thesis attempts to thoroughly examine the effects of a STEM major on officer performance and retention to deliver an assessment that the U.S. Navy can use in future policy making. Moreover, this thesis hopes to provide information to help shape where the Navy directs its resources in regard to officer training. The results of this study may also help improve job matching among Navy officers and provide an effective tool in the talent management inventory.

III. LITERATURE REVIEW

This chapter reviews the most relevant prior studies that have examined measures of Navy officer performance. While several studies have examined the relationship between pre-commissioning characteristics and junior officer career progression and performance, few previous studies have specifically examined the effects of STEM degrees on junior officers.

A common theme throughout previous studies is that a STEM background is unimportant to performance and retention. Additionally, the cohorts of officers observed were much older in comparison to the cohorts of officers used in this thesis. The following studies offer important and relevant background information directly related to this thesis' central theme.

A. EXAMINING THE RICKOVER HYPOTHESIS

The Rickover hypothesis is based on Adm. Hyman Rickover's belief that "a technically trained undergraduate will make a better officer" (Bowman 1990). The Rickover hypothesis was first investigated further by Bowman (1990) in his study "Do Engineers Make Better Officers?" His study specifically observes officers commissioned from the U.S. Naval Academy who selected into the surface and submarine communities. As previously mentioned, the Naval Academy has mandated that a majority of their graduates major in a STEM field.

Bowman's data consists of 1,560 U.S. Naval Academy graduates from the classes of 1976–1980. He specifically examines graduates who service selected the surface warfare community or the submarine community, which he argues are the communities most likely to require technical degrees. Bowman employs two models in his study to measure junior officer fleet experience (Bowman 1990, 271–286). This first model examines officer performance; the second model examines officer retention. In order to observe the performance and retention of officers by degree, Bowman (1990) uses a logit estimation technique because the dependent variables are all binary. Bowman defines superior performance as when an officer receives an early promotion recommendation in addition to being ranked in the top 1 percent category for both “command desirability” and “overall summary” (Bowman 1990, 274). Bowman measured whether an officer was a superior performer (1=yes, 0=no), and whether an officer stayed at least six months beyond their initial obligation (1=yes, 0=no). Bowman’s logit coefficients were converted to marginal effects to measure the effect of changes in each independent variable on the probability of either being a superior performer or on retention at least six months beyond the initial service obligation.

During the period covered by Bowman’s data, Midshipmen from the Naval Academy selected the designator they preferred (SWO, SUB, etc.). Upon selection they must be accepted into the community therefore a highly selective community such as the nuclear Navy will likely have the highest quality junior officers upon commissioning. The officers that select into the nuclear Navy typically have a higher GPA than their peers and overwhelmingly have technical majors. Because assignment to community is not random, selection effects may bias the estimated effects of a STEM major. Despite using the Heckman procedure to correct for potential self-selection bias (Wooldridge 2009), Bowman’s results are no different than without the correction. Bowman decided to use a model without the Heckman procedure for simplicity.

An important aspect of Bowman’s model is that he controls for job factors and environment in order to compare officers in similar job conditions. For example, the experiences and responsibilities of an administrative officer on a frigate will vary significantly from an operations officer on an aircraft carrier. Bowman notes that performance evaluations and retention vary in some cases significantly across platforms and occupations. The results from Bowman (1990) are reproduced in Table 1.

Table 1. Impact of Academic Measures on Junior Officer Performance and Retention by Warfare Communities

Impact of Academic Measures on Junior Officer Performance and Retention by Warfare Communities

	Change in Probability of Attaining Superior Officer Rating*		Change in Probability of Staying Beyond Initial Obligation*	
	Conventional	Nuclear	Conventional	Nuclear
Academic major relative to engineering major				
Math/physical sciences	.046 (0.73)	−.037 (0.76)	−.017 (0.43)	.039 (0.88)
Humanities/social sciences	.099 (1.35)	.065 (0.75)	.062 (1.31)	−.008 (0.11)
Management/ economics	.241 (2.15)	.248 (1.17)	.041 (0.60)	−.038 (0.19)
General engineering/ sciences	.050 (0.66)	−.228 (1.28)	.083 (1.66)	.170 (1.22)
One-point differential in grade point averages in				
Engineering	−.041 (0.71)	.099 (1.56)	−.005 (0.14)	−.131 (2.24)
Math/physical sciences	.032 (0.49)	−.104 (1.45)	−.045 (1.10)	.043 (0.64)
Humanities/social sciences	−.043 (1.40)	−.029 (0.52)	−.026 (0.67)	.029 (0.57)

*Probability estimates are nonlinear transformations of the logit parameters evaluated at the mean level of all independent variables. *T*-values of logit parameters are given in parentheses.

Source: Bowman, W. R. (1990). Do engineers make better naval officers? *Armed Forces & Society 16*(2), 271–286.

His results suggest that academic majors, including STEM degrees, have little effect on performance and retention of junior officers in the Surface and Subsurface Communities. A majority of the academic major variables for junior officers were not statistically significant. The only major that was statistically significant was the management/economics major. A degree in management/economics, compared to an engineering degree, increased the likelihood of a junior officer in the conventional surface community of attaining superior fitness report performance by 24 percentage points. Regarding retention, a general engineering/sciences degree increased the likelihood of staying beyond the initial five-year obligation by 8.3 points relative to an engineering major.

Bowman’s results suggest that social science, humanities and economics graduates of the U.S. Naval Academy may benefit from both the technical skills accumulated from basic core math and engineering courses as well as the interpersonal skills acquired through their non-technical majors. A pure STEM major misses out on the interpersonal skills of non-STEM majors. Interpersonal skills may be an important consideration in job performance because the responsibilities of a junior officer go beyond being technically skilled. A junior officer must be able to lead, have good judgement, and know how to work with people. Junior officers, especially in the Surface and Subsurface Communities have duel responsibilities of leading a division often to 30 people while simultaneously becoming familiar with the technical platforms on which they serve. This thesis further investigates the potential that a solid foundation of STEM mixed with social skills is a successful formula for junior officer performance.

An issue with Bowman’s study is that using solely USNA officers for the analysis of STEM degrees may create a downward bias on the effect of STEM degrees simply because all USNA graduates complete a core of technical, science, engineering, and math courses. Additionally, Bowman mentions that Naval Academy graduates account for approximately 18 percent of commissioned officers and thus his results apply only to this group. Also, Bowman includes only males in his data set. This thesis investigates data that includes female graduates. Additionally, his data only follows the USNA graduates during their initial five-year obligation, the composition of which is different than today’s junior officers. For example, at the time of this study, Surface Warfare Officers’ initial sea tour was four years. Today, the initial sea tour is two years followed by second two-year sea tour typically on a different ship.

Another potential issue with Bowman’s study is that in a community like the subsurface community the backgrounds of officers are very similar. According this his data, almost 90 percent of submariners had STEM degrees and almost 90 percent had high GPA’s. Due to the lack of variation in college backgrounds among this group it is difficult to estimate differences in the effects of STEM degrees. Moreover, Bowman’s study found that “a one point differential in an engineering or math-physical sciences GPA increases the probability of a graduate becoming a nuclear-trained officer by 22.7

percent and 27.8 percent, respectively" (Bowman 1990, 271–286). This is important because it suggests that high performing STEM Midshipmen are more likely to become nuclear-trained officers instead of conventional surface officers. Bowman's findings suggest that submariners compose an inherently high-performing community.

A high-performing community predominantly comprised of STEM officers may be more susceptible to officers leaving the service for better opportunities in the civilian market. When one considers the high demand for STEM degrees in the civilian labor market and the nuclear power training of submariners, the increased likelihood of high performing officers to leave after their obligated service should be heavily considered. However, within the conventional surface Navy, a general engineering/sciences major relative to an engineering major showed an 8.3 percent increase likelihood of staying beyond their initial service obligation (Bowman 1990, 283).

Another important factor to consider is that, according to Bowman (1990) "no more than 20 percent of all midshipmen were permitted to select humanities/social science majors during the period of study" (Bowman 1990, 271–286). The requirement that 80 percent of midshipmen select a STEM major may indicate some STEM graduates may have been reluctant to choose their major. Consequently, they may have underperformed in their majors and not attained the knowledge and skills of those who willingly chose a STEM major, perhaps reflected in lower GPAs. These underperforming STEM majors would self-select into the conventional surface Navy and potentially negatively bias the performance effect of STEM degrees in that community.

In his conclusion, Bowman suggests that a more feasible test of the Rickover hypothesis would be to examine junior officers commissioned from a variety of sources as well as officer performance later in their careers. This thesis investigates the performance of junior officers commissioned from all commissioning sources as well as follows the career progression of officers beyond their initial obligation. Furthermore, this thesis not only applies the improvements suggested by Bowman (1990) but also incorporates data on more recent cohorts in order to capture recent policy changes in the various URL communities.

B. THE RELATIONSHIP BETWEEN COLLEGE MAJOR AND JOB PERFORMANCE

O’Connell (1998) examined the relationship between job performance, measured by promotion and FITREP scores, and college selectivity, college major, and college grade point average. The goal of O’Connell (1998) was to test the hypothesis of a positive relationship between the job performance of Navy officers and college selectivity, college major, and college grade point average. In addition, O’Connell (1998) specifically addressed the hypothesis that naval officers with a STEM background would outperform their non-STEM peers. O’Connell divided his sample into operational and staff officers, and then sub-divided the groups into specific community. His findings indicate that STEM degrees did not have an effect on junior officer performance or promotion. Rather, he found a positive impact on performance for officers who had a business/management degree.

O’Connell’s 1998 study only includes OCS graduates and omits prior enlisted officers, NROTC, and United States Naval Academy graduates. Focusing on OCS graduates eliminates potential biases due to USNA and NROTC graduates having a technical core curriculum. Another reason USNA and NROTC graduates were omitted from O’Connell’s study was to prevent selection bias specifically regarding college quality. The U.S. Naval Academy is a very selective institution. Additionally, the variation in quality across NROTC universities is somewhat limited due to the small number of NROTC units. O’Connell (1998) also points out that the extensive military knowledge and skills acquired by USNA or NROTC graduates, as well as prior that of enlisted officers, could skew the results of his study. The scope of O’Connell’s study was much broader than the scope of this current thesis in that the current study focuses mainly on the impact of STEM degrees.

The initial data set used by O’Connell (1998) included 24,672 operational officers and 9,356 staff officers who began their careers between the years 1976 and 1985. But by restricting attention to only OCS graduates, his analysis data included only 2,911 operational officers in his promotion model and 5,329 operational officers in his performance model. Additionally, he includes 2,240 staff officers in his promotion model and 2,912 staff officers in his performance model. As previously mentioned, the basis for only including OCS graduates stems from their diverse educational backgrounds and minimal military human capital thus they are essentially equals upon entering military service. By analyzing only OCS graduates, O'Connell (1998) saw an opportunity to measure the effects of college background in an unbiased sample of Navy officers.

The operational officers in O'Connell (1998) are of specific significance because that is where STEM degrees are expected to be the most useful. Operational officers are Navy officers serving in the Surface Warfare, Submarine, Pilot, Naval Flight Officer, or other Unrestricted Line communities. Staff officers are Navy officers serving in the Staff, Restricted Line, or General Unrestricted Line communities.

Similar to Bowman (1990), O'Connell's data underrepresents females quite significantly relative to their current proportion of Navy officers. In O'Connell's data only 1.7 percent of operational officers are female whereas 43.1 percent of staff officers were female (1998). In the full data set used in this thesis, Female officers represent nearly 20% of the Unrestricted Line (URL) Officers which are equivalent to operational officers. This thesis provides a more contemporary representation of the effects of STEM degrees on officer performance and promotion by gender.

O'Connell (1998) employs two models analyzing promotion and performance of junior officers. Additionally, while analyzing college majors, he uses multiple explanatory variables for Engineering, Physical Sciences, Math, Social Sciences, Business/Economics, and Humanities degrees. The variables Engineering, Physical Sciences and Math are combined into STEM degrees.

In his first model he uses the binary dependent variable "PROMO" to indicate whether an officer was selected for O-4 or not; this variable equals 1 if the officer was selected early or in-zone for O-4 and equals 0 otherwise. O'Connell uses a logit model arguing "a logit model is more efficient for binary dependent variables" (O'Connell 1998). The logit model allows the estimated coefficients to be converted to marginal effects, which measure the effect of changes in each independent variable on the probability of promotion.

In O'Connell's promotion model, approximately 41 percent of operational officers and approximately 27 percent of staff officers were STEM majors. As previously stated, the U.S. Naval Academy and NROTC are required to commission at least 65 percent of their officers with STEM degrees. For the purposes of his study, O'Connell mentions that the U.S. Naval Academy and NROTC program directly influence the majors of their graduates in comparison to OCS commissioned officers who were free from external military policy to select their major.

O'Connell (1998) uses multiple explanatory variables to capture the effects of college quality and academic background. The first group of explanatory variables examines college quality based on Barron's Profiles of American Colleges scale (O'Connell 1998). College quality has been shown in previous research to correlate with higher earnings in the civilian labor market (Zhang, 2005) therefore O'Connell hypothesized that college quality would be associated with increased promotion and performance among Navy officers. The second group of variables is college major. Additionally, O'Connell uses grade point average and a graduate degree as explanatory variables because they also correlate to higher earnings in the civilian workforce.

O'Connell's results are presented in Table 2. In the promotion model, none of the STEM variables are statistically significant compared to humanities majors; however, the Social Science and Business/Economics variables are significant in comparison to the omitted humanities degree. Among operational officers in the promotional model, a Business/Economics degree is associated with a 3.10 percentage point increase in the likelihood of promotion to O-4. Among staff officers, both the Social Science and Business/Economics variables are statistically significant and are associated with a 4.46 and 3.87 percentage point increase, respectively, in the likelihood of promotion to O-4. While these results may be expected in the Staff Community, the insignificant effects of a STEM degree in the operational community are somewhat surprising.

The second model O'Connell employs analyzes performance of junior officers using the dependent variable "PCTRAP13." This variable specifically examines the percent of FITREPS with "recommendations for early promotion (RAPs)" between O-1 and O-3. O’Connell employs an ordinary least squares model to analyze the performance of junior officers on fitness reports because the dependent variable is continuous.

In O’Connell’s fitness report model the STEM explanatory variables were statistically significant in some instances while the Social Science and Business/ Economics variables were mostly insignificant (compared to the omitted humanities major). Operational Officers with a math degree received 5.9 percent fewer RAPs while all other variables were insignificant. Regarding Staff Officers, STEM degrees had a statistically significant negative impact on RAPs while a Business/Economics degree had a positive impact. Staff Officers with a Business/Economics degree received 2.81 percent more RAPS (recommendations for early promotion) than humanities officers.

Table 2. The Marginal Effects of College Quality, College Major, and GPA on Promotion to O-4 and FITREP Performance

TABLE III. MARGINAL EFFECTS OF COLLEGE QUALITY AND EDUCATION VARIABLES IN PROMOTION AND FITREP MODELS

VARIABLE	Marginal Effect (in percentage points)			
	Operational	**Staff**	**Operational**	**Staff**
	Promotion to O-4		% FITREPs RAP'd	
Mean(%)	75.7	73.7	52.7	55.9
College Quality (Very Competitive Omitted)				
Most Competitive	2.26	9.01*	4.04*	4.36
Highly Competitive	0.38	0.54	4.60***	0.30
Competitive	-1.74	-1.49	-0.79	0.25
Less Competitive	-3.10	-2.93	-1.52	0.60
Non Competitive	-0.74	0.23	-2.26	-2.19
College Major (Humanities Omitted)				
Engineering	2.27	1.22	-1.33	-5.76**
Physical Science	1.72	1.36	-0.81	-2.55**
Math	5.06	-4.71	-5.95***	-4.79*
Social Science	1.70	3.87*	0.19	2.16
Business/Economics	3.10*	4.46**	1.10	2.81*
Other Education Factors				
Grade Point Average Measure	2.28***	1.84***	2.90***	1.50**
Graduate Degree	2.25***	9.16***	-	-

*** - significant at 99 percent
** - significant at 95 percent
* - significant at 90 percent

Source: O'Connell, R. F. (1998). The effect of college selectivity, grades, and major on the job performance of officers in the U.S. Navy (Doctoral dissertation, Monterey, California. Naval Postgraduate School).

Although the main focus of O'Connell (1998) study was to analyze job performance through the examination of college selectivity and academic performance, a major pillar of his research investigated the effect of academic majors on officer performance. O'Connell's results do not support the hypothesis that junior officers with STEM degrees outperform and out-promote junior officers with non-STEM degrees. This may be a product of only analyzing OCS commissioned officers who statistically commission with a lower percentage of STEM degreed officers compared to U.S. Naval

Academy and NROTC officers. His study did, however, find significant and positive effects of an economics/management degree on FITREP performance (based on RAPs). Moreover, his study found that within the operational community a mathematics degree had a significant and negative effect on FITREP performance. While the composition of OCS officers is important to consider, the level playing field created by O'Connell in using only OCS officers does not support the Rickover hypothesis.

A significant shortfall in the analysis of college major on officer performance is that O'Connell (1998) does not address the impact of STEM degrees based on warfare community. While he separates communities into either operational or staff, regarding the operational community, the utilization of a STEM degree within the submarine community is probably significantly different than in the Special Forces community. O'Connell specifically mentions this shortfall in his conclusion. This is an area that this thesis examines. Specifically, a STEM degree is hypothesized to have a positive influence on more technical operational communities such as the surface warfare community and submarine community.

C. THE EFFECTS OF COLLEGE QUALITY AND COLLEGE MAJOR ON JUNIOR OFFICER PERFORMANCE

Mehay and Bowman (2002) conducted a study built upon previous research into the effects of college quality on civilian job performance. What is unique about their study is that it examines data from one organization (the Navy) where career paths, starting job occupation, and numerous other factors are similar in comparison to previous research in the civilian sector that struggled to find objective measurements of performance. The Navy provides a unique environment where career paths and performance measures are largely similar, especially within communities, thus allowing for a revealing analysis into the importance of college quality and academic achievement.

Mehay and Bowman (2002) use three job performance measures and analyze the performance of officers during three separate periods of commissioned service. Specifically, their performance measures analyze an officer's first four years, years four through ten, and beyond ten years. In order to accurately measure performance among officers during their first four years and years 4–10, Mehay and Bowman use officer FITREPS. Mehay and Bowman note the most accurate measure of performance based on FITREPS is the recommendation for promotion. The FITREPS of specific relevance are the ones with a "recommendation for accelerated promotion" (RAP). An officer's superior generally has a limited number of early recommendations they can give therefore it is incumbent upon them to use these recommendations on only the most deserving officers. These evaluations indicate superior performance and productivity. Mehay and Bowman address the potential for self-selection bias in the O-3 promotion model by using a "Heckman style two-step model" (Mehay and Bowman 2002, 709). This accounts for the officers who attrite prior to being selected for O-3 or simply leave the service in favor of better opportunities in the civilian workforce.

Regarding the third job performance measure that examines officers beyond ten years of commissioned service, Mehay and Bowman analyze promotion to O-4. Mehay and Bowman attempt to eliminate self-selection bias in their third performance model "by explicitly modeling the stay-leave decision using quasi-cohort data" (Mehay and Bowman 2002, 702). Specifically, they use a bivariate probit model because officers in the third job performance model have binary outcomes in that both the retention and promotion outcomes are binary (Mehay and Bowman 2002, 709). In addition to controlling for retention and promotion of officers in the line and staff specialties, Mehay and Bowman account for the promotion opportunities within the two specialties. Promotion to O-4 is not the same each year and is driven by a number of factors; therefore in order to accurately account for a year's promotion quota Mehay and Bowman included year dummy variables in the promotion model.

In their data, Mehay and Bowman (2002) followed Navy officer cohorts from 1976 to 1985 for ten years after commissioning. The data included 27,604 personnel. Mehay and Bowman (2002) found results similar to O'Connell's regarding the effects of college major on performance and promotion for line officers and staff officers. Similarly to O'Connell's study, Mehay and Bowman find that STEM degrees negatively affect staff officers' FITREPs more than those of line officers. Regarding FITREP performance measures, both studies used an early promotion recommendation as their binary variable.

Specifically, for both line and staff specialties they analyzed officers' performance evaluations for O-1 to O-2, and O-3 and they examined promotion rates to O-4. Additionally, O'Connell (1998) and Mehay and Bowman (2002) use six classifications for college quality derived from Barron's *Profiles of American Colleges*. Another similarity between O'Connell (1998) and Mehay and Bowman (2002) is their use of six categories of college majors. Table 3 shows the results of Mehay and Bowman's performance models for line officers.

Table 3. Education and Demographic Results for Line Officers

***Table 2.* Performance Models for Line Specialties.**

Variable	*Outcome Variables* *Performance Evaluation, Grades 1–2*	*Performance Evaluation, Grade 3*	*Grade 4 Promotion Probit*
Top-Rated Private	.089*** (.015)	.086*** (.014)	.161** (.078) [.049]
Middle-Rated Private	.020 (.014)	.039*** (.013)	.044 (.069) [.013]
Bottom-Rated Private	−.003 (.025)	−.022 (.022)	−.238** (.111) [−.073]
Top-Rated Public	.042** (.018)	.014 (.016)	.074 (.089) [.021]
Middle-Rated Public	.016 (.011)	.013 (.010)	.049 (.053) [.015]
Engineering Major	.015 (.010)	.003 (.008)	.043 (.047)
Science Major	−.043*** (.011)	−.043*** (.011)	.037 (.063)
Math Major	−.021 (.013)	.034*** (.003)	.148*** (.017)
Business Major	.018 (.011)	.011 (.009)	.126** (.053)
Humanities Major	−.029** (.013)	−.014 (.012)	−.092 (.064)
GPA	.054*** (.003)	.041*** (.003)	.155*** (.016)

Variable	*Outcome Variables* *Performance Evaluation, Grades 1–2*	*Performance Evaluation, Grade 3*	*Grade 4 Promotion Probit*
Age	−.003* (.001)	−.001 (.001)	−.065*** (.008)
Married	.090*** (.010)	.032*** (.009)	.221*** (.047)
Married and Children	.108*** (.007)	.049*** (.008)	.318*** (.041)
Unmarried and Children	.064* (.034)	−.002 (.024)	.064 (.121)
African-American	−.065*** (.018)	−.048*** (.017)	−.117 (.086)
Other Minority	−.030 (.022)	−.018 (.021)	−.140 (.108)
Female	.058** (.027)	.013 (.026)	.605** (.161)
Intercept	.205	.585	1.643
N	14,862	8,895	7,946
R^2	.040	.038	—
−2 Log L	—	—	8,586.08
Joint Hypothesis Tests			
College Majors	<.0001[a]	<.0001[a]	.0036[b]
College Selectivity*Female	.8046	.6972	.6896
College Selectivity*Af.-Am.	.2638	.9201	.9731
Marital Status*Female	.8012	.5369	.6933
Marital Status*Af.-Am.	.7664	.4083	.4949

Source: Bowman, W. R., & Mehay, S. L. (2002). College quality and employee job performance: Evidence from naval officers. *Industrial & Labor Relations Review* 55(4), 700–714.

The results of the FITREPs model for line officers in Mehay and Bowman’s study suggest that college major has little impact on performance across all grades. Surprisingly, social science majored officers actually outperform STEM majored officers in this model. Regarding promotion to O-4, this model finds no statistically significant differences in promotion among majors with the exception of business majors who promote at a higher rate.

The results of Mehay and Bowman (2002) are not necessarily an indictment on STEM degrees with regard to line officers. Rather, the model may indicate the effectiveness of formal training provided by the Navy for line occupations. There is extensive training required for line officers that may provide non-STEM officers a crash course in technical skills needed for their job. However, this training has varied significantly over time especially in the surface warfare community. SWO training has evolved from a six month resident training program to computer-based training to a six week localized training command. During the period that the data for Mehay and Bowman’s study covered, surface warfare officers went through a robust six-month resident training curriculum that may have allowed non-STEM officers to acquire the required technical skills to close any gap they had with their STEM peers. This may explain why Mehay and Bowman’s data suggests GPA and college quality are the most important indicators of performance. High academically performing officers may be better able to absorb and implement formal Navy training in relation to less academically inclined officers.

Table 4. Education and Demographic Results for Staff Officers

Table 3. Performance Models for Staff Specialties.

Variable	Outcome Variables: Performance Evaluation, Grades 1–2	Performance Evaluation, Grade 3	Grade 4 Promotion Probit
Top-Rated Private	.058**	.073***	.282**
	(.020)	(.017)	(.099)
			[.081]
Middle-Rated Private	.011	.025*	–.049
	(.017)	(.014)	(.074)
			[–.014]
Bottom-Rated Private	.071**	.046*	.058
	(.032)	(.026)	(.136)
			[.016]
Top-Rated Public	.013	.013	–.039
	(.025)	(.021)	(.114)
			[–.011]
Middle-Rated Public	.004	.019*	.010
	(.013)	(.010)	(.056)
			[.002]
Engineering Major	–.087***	–.065***	.068
	(.015)	(.012)	(.072)
Science Major	–.073***	–.053***	–.005
	(.016)	(.013)	(.072)
Math Major	–.066***	–.034**	.042
	(.020)	(.017)	(.092)
Business Major	–.014	.043***	–.009
	(.013)	(.011)	(.062)
Humanities Major	–.065***	–.019	–.114
	(.015)	(.012)	(.078)
GPA	.035***	.020***	.101***
	(.005)	(.004)	(.022)

Variable	Outcome Variables: Performance Evaluation, Grades 1–2	Performance Evaluation, Grade 3	Grade 4 Promotion Probit
Age	.009**	.002*	–.026***
	(.001)	(.001)	(.007)
Married	.075***	.035***	.197***
	(.014)	(.012)	(.065)
Married and Children	.086***	.021**	.125**
	(.011)	(.010)	(.055)
Unmarried and Children	.072***	.023	.057
	(.032)	(.023)	(.120)
African-American	–.089***	–.060***	–.261***
	(.021)	(.017)	(.092)
Other Minority	–.066**	–.025	–.065
	(.029)	(.024)	(.129)
Female	.016	–.018*	.179***
	(.011)	(.010)	(.057)
Intercept	.024	.608	.979
N	6,675	4,797	4,535
R^2	.091	.043	—
–2 Log L	—	—	5,134.68
Joint Hypothesis Tests:			
College Majors	<.0001[a]	<.0001[a]	.3925[b]
College Selectivity*Female	.4188	.5638	.7940
College Selectivity*Af.-Am.	.0076[c]	.0001	.2371
Marital Status*Female	.0004[d]	.7367	.3206
Marital Status*Af.-Am.	.3073	.3778	.3451

Source: Bowman, W. R., & Mehay, S. L. (2002). College quality and employee job performance: Evidence from naval officers. *Industrial & Labor Relations Review* 55(4), 700–714.

As in previous research, according to Table 4 STEM officers appear to perform worse in the staff specialties than in the line specialties. One explanation for this could be that Staff jobs require interpersonal skills that are more likely to be acquired via non-technical majors rather than via STEM majors. This may be the result of a failure in job matching where STEM degreed officers are ill-suited for the interpersonal environment of staff duty. While the results were not statistically significant in the promotion to O-4 model for any of the STEM majors, the negative effects of a STEM major on FITREPs in the Staff specialty model would suggest a negative effect on O-4 promotion.

One plausible explanation for the negative performance and promotion outcomes for STEM majors in Mehay and Bowman (2002) may be due to a higher propensity for STEM-degreed officers to leave the Navy for better opportunities in the civilian market or for URLs to lateral transfer to Staff/RL communities. A STEM officer who has expressed their desire to leave the Navy after their obligated service may receive a worse performance evaluation in comparison to a social science officer who has fewer opportunities in the civilian job market and intends to stay in the Navy beyond their obligated service. However, based on Mehay and Bowman's retention models, STEM officers are no less likely than non-STEM officers to stay in the Navy (although they did not have data on lateral transfers). This may conflict with the narrative that the low-performing STEM officers stay while high-performing STEM officers leave for more lucrative opportunities in the civilian sector.

Regarding promotion rates, there are a larger percentage of STEM officers in Line specialties in comparison to Staff specialties. This is important to consider because traditionally Line officers have promoted to O-4 at lower rates than Staff officers. The promotion rates of Line officers would have a negative bias on the effect of a STEM major on promotion to O-4. Additionally, Mehay and Bowman observe that "… the coefficients of student achievement and major also could be affected by self-selection of leavers, since college achievement may also affect one's civilian employability" (Mehay and Bowman 2002, 711). This supports the possibility that a community dominated by STEM officers could display negative effects of a STEM degree due to self-selection. A community such as the submarine community is dominated by officers with STEM majors; however, the community continually faces retention issues due to lucrative civilian employment opportunities and must offer retention bonuses to achieve retention targets.

Mehay and Bowman's study does not support the Rickover hypothesis that STEM officers are better performers than non-STEM officers. In fact, their study indicated that GPA and college quality were the most important factors in explaining job performance. This thesis takes into account college quality but not GPA in determining the significance of a STEM officer's performance. This thesis offers an updated assessment of cohorts related to STEM as the technology in the U.S. Navy has changed dramatically since the data captured in Mehay and Bowman (2002).

While Mehay and Bowman (2002) did not address specific warfare communities, Parcell (2003) examines the three Unrestricted Line communities; Surface, Aviation and Subsurface. In her study, performance metrics are based on meeting career milestones such as promotion to O-3, O-4, O-5, and O-6 and attaining command at sea. Parcell (2003) does not find any statistically significant effects of college major on promotion or attaining command at sea. This is a significant finding especially regarding the perceived potential usefulness of a STEM degree in a technical warfare community such as the surface or subsurface warfare community. The Rickover hypothesis is not supported by this study.

This thesis not only provides an analysis of the performance of STEM officers but also allows for a comparison to previous studies of STEM officer performance. Moreover, it examines if STEM officers commissioned in the Navy are more or less prepared compared with historical standards. In other words, it looks at whether STEM degrees are evolving as quickly as U.S. Navy technical requirements. While none of the studies reviewed in this thesis found any effects of STEM majors on career outcomes, this thesis revisits the Rickover hypothesis in an attempt to further investigate the effects of STEM degrees on Navy officers.

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IV. DATA DESCRIPTION

The data used in this study came from the Defense Manpower Data Center (DMDC) and Bureau of Naval Personnel/Navy Personnel Command (BUPERS-NPC). Data records for Navy officers are used for descriptive analyses. In addition, longitudinal data files for officer cohorts were created to facilitate the analysis of career progress by selected cohorts of commissioned officers. Longitudinal files for cohorts commissioned in fiscal years 1999 to 2003 were created to track junior officer career progress. The analysis data collection follows entry cohorts longitudinally for as long as ten years of service. The thesis uses multivariate estimating techniques to analyze the effects of demographics and college background characteristics on performance of junior officers. Explanatory variables include commissioning date, commissioning source, college quality, major, separation date, pay-grade, date of promotion, marital status, dependents, race, and fitness reports (FITREPS).

The initial data set included over 24,000 officer data files. After cleaning the file and removing missing and incomplete entries the officer data file dropped to roughly 16,000 entries. However, FITREP information was not provided for all officers in the DMDC cohort files and dropping observations without FITREP information left about 8,500 officer data files. In order to examine performance through FITREPS as well as other metrics, this thesis uses two separate analysis data sets. The first data set used does not include FITREP data and contains approximately 16,000 observations. The second analysis data set is used to analyze FITREP data as a metric for performance and includes about 8,500 officer observations.

A. FULL DATA SET ANALYSIS

There are 16,143 observations in the first analysis data set comprised solely of Navy officers who commissioned between fiscal years 1999 and 2003. Included in this data set are various demographic features of the commissioned officers at the time of commissioning and at least ten years beyond commissioning. Table 5 shows the number of observations for each cohort as well as the representation of All-STEM and Limited-

STEM graduates in each cohort. The difference between the two STEM definitions is the specificity and overall relevance to the Navy. The All-STEM variable is derived from the Tier 1 and Tier 2 NROTC Degree List but excludes economics (Naval Service Training Command Officer Development 2016). Tier 1 degrees are defined as "engineering programs of Navy interest" and Tier 2 degrees are defined as "other engineering, math and science programs" (Naval Service Training Command Officer Development 2016). The Limited-STEM variable is limited to only Tier 1 NROTC offered degrees but also includes Civil Engineering, Ordnance Engineering, Computer Science, Physics, and Mathematics. As previously stated, one goal of this thesis is to examine how the Navy defines STEM majors for the purposes of commissioning officers with technical backgrounds which are relevant to Navy occupations and compare that with at least one other STEM definition. There is a small variation in the number of observations in each cohort because Navy accession requirements vary each year.

Table 5. Distribution of STEM Degrees by Cohort in Full Data Set

Cohort (Fiscal Year)	Number of Observations	All-STEM	Limited-STEM
1999	2,961	1,402	719
2000	3,355	1,541	787
2001	3,403	1,512	795
2002	3,322	1,468	846
2003	3,102	1,453	784
Total Observations	16,143	7,376	3,931

Table 5 shows a fairly even distribution of officers with STEM majors defined by the NROTC Tier 1 and Tier 2 scholarship lists in each cohort. A little over half of the officers in the analysis data set have a major considered STEM by NROTC scholarship standards. Additionally, Table 5 shows that the number of officers with the more Navy-oriented *Limited-STEM* degree definition used in this thesis are a considerably smaller group than the *All-STEM* group. The *Limited-STEM* degrees make up nearly one fourth of the analysis data set. Using two different STEM definitions should provide a clearer picture of the effect of STEM degrees. The inclusion of two separate STEM definitions will test the impact of different STEM degrees on officer performance. A stricter STEM definition may indicate whether the type of STEM degree is important or if any STEM degree is sufficient. The STEM field is a very broad field and a sizable portion of the data set falls under the STEM definition. By applying a stricter definition of STEM as it relates to Navy occupations may allow for more targeted STEM policies in the future.

1. Dependent Variable Descriptions for Full Data Set

The purpose of this thesis is to measure the effect of STEM degrees on performance, promotion, and retention of Navy JOs. In this data set two of the three areas are measured, namely promotion and retention. However, promotion can reasonably be considered a signal for above-average prior job performance. Table 6 displays the dependent variables used to determine the effect STEM degrees have on junior Navy officers.

Table 6. Dependent Variable Descriptions

Dependent Variable Descriptions	
Variable	**Definition**
MSR Retention	=1 if retained beyond MSR, otherwise=0
Ten Year Retention	=1 if greater than 10 years commissioned service, otherwise=0
O-4 Promotion	=1 if promoted to O-4, otherwise = 0

a. MSR Retention

The first retention variable analyzed in this thesis is retention beyond an officer's Minimum Service Requirement (MSR). Upon commissioning, Navy officers are required to serve a minimum number of years in return for the college education or educational benefits received during undergraduate and graduate school. When an officer fulfills their required service they have the choice of leaving the Navy or continuing their career. Essentially, the Navy has educated an officer and intends to utilize their skills. Retaining an officer beyond their MSR provides the Navy with a higher return on its educational investment. Although retention beyond MSR is not necessarily a signal of quality, it can be a sign of a good return on investment. For example, Surface Warfare Officers commissioned from the U.S. Naval Academy are required to serve a minimum of five years after graduating in return for the four years of undergraduate education they received. Retaining a Surface Warfare Officer for greater than their five year commitment in this circumstance extends the benefits of the Navy's initial investment in that officer.

b. Ten Year Retention

The second retention metric used in this thesis examines Ten Year Retention. This variable examines the effect of a STEM degree on officers who stay beyond their MSR but not to ten years of commissioned service. A major aspect of the Ten Year Retention mark is that it provides a look at those who continued their career long enough to be in-zone for O-4 promotion. As previously mentioned in this thesis, a STEM degree is highly desirable in the civilian labor force; therefore an officer can conceivably serve beyond their MSR, obtain a graduate degree through the Navy, and leave the service. However, a Navy funded graduate degree typically requires additional service and, based on the timing, extend an officer's career to be in-zone for promotion to O-4. Examining this variable provides insight into the retention of technically skilled officers.

c. O-4 Promotion

Promotion to O-4 is the first competitive promotion process for commissioned officers that require a selection board. This is the first opportunity for officers to be ranked against their peers regarding career progression. A selection to O-4 signals an officer's competitiveness and competency in comparison to their peers. Comparing the O-4 selection rates of officers with STEM degrees to officers without STEM degrees demonstrates the effect of a STEM degree on promotion in this data set.

2. Independent Variable Descriptions for Full Data Set

Table 7 presents the definitions of the independent variables used in this thesis.

Table 7. Independent Variable Descriptions

Variable	Definition
Demographics	
Female	=1 if Female, otherwise =0
Male	=1 if Male, otherwise =0
Dependent Children at 2YOS	=1 if dependents 2 years after commissioning, otherwise =0
No Dependent Children at 2YOS	=1 if no dependents 2 years after commissioning, otherwise =0
Black	=1 if Black (race) & Non-Hispanic (ethnicity), otherwise =0
White	=1 if White (race) & Non-Hispanic (ethnicity), otherwise =0
Asian	=1 if Asian, otherwise =0
Hispanic	=1 if Hispanic, otherwise =0
Unknown Race	=1 if Race is not known, otherwise =0
Married	=1 if married at time of commissioning, otherwise =0
Not Married	=1 is not married at time of commissioning, otherwise =0
Commissioning Details	
Prior Enlisted	=1 if Prior Enlisted, otherwise =0
Naval Academy	=1 if commissioned from USNA, otherwise =0
ROTC	=1 if commissioned from ROTC, otherwise =0
OCS	=1 if commissioned from OCS, otherwise =0
Direct	=1 if direct commissioning, otherwise =0
Other Commissioning	=1 if commissioned from other source, otherwise =0
Education	
All-STEM	=1 if Officer has All-STEM degree, otherwise=0
Limited-STEM	=1 if Officer has Limited-STEM degree, otherwise=0
Graduate Education	=1 if Officer has Postgraduate Degree, otherwise=0
University Competitiveness High	=1 if school rated as Most Competitive, otherwise=0
University Competeveness Medium	=1 if school rated as Highly Competitive or Very Competitive, otherwise=0
University Competitiveness Low	=1 if school rated as Competitive, Less Competitive, or Non-Competitive otherwise=0
Navy Community	
Surface Warfare	=1 if Surface Warfare Officer, otherwise =0
Submarine	=1 if Submarine Officer, otherwise =0
Aviation	=1 if Naval Pilot, otherwise =0
Special Operations	=1 if Special Operations Officer, otherwise =0
Restricted Line (RL)	=1 if Restricted Line Community, otherwise =0
Staff	=1 if Staff Community, otherwise =0
Unrestricted Line (URL)	=1 if Unrestricted Line Community, otherwise =0
Non-Technical Restricted Line or Staff	=1 if Non-Technical Restricted Line or Staff Community
Technical Staff or RL	=1 if Technical RL or Staff Community
Cohorts	
Cohort FY99	=1 if commissioned during fiscal year 1999, otherwise=0
Cohort FY00	=1 if commissioned during fiscal year 2000, otherwise=0
Cohort FY01	=1 if commissioned during fiscal year 2001, otherwise=0
Cohort FY02	=1 if commissioned during fiscal year 2002, otherwise=0
Cohort FY03	=1 if commissioned during fiscal year 2003, otherwise=0

a. Education

In the analysis data, officers were coded into the variable *All-STEM* when officers possessed an undergraduate or graduate STEM degree; those with an *All-STEM* degree were coded =1 and =0 if otherwise. Table 8 highlights the degrees that are considered *All-STEM*. This list was derived from the NROTC Scholarship degree list (Naval Service Training Command Officer Development 2016) as well as the Manual of Navy Officer Manpower and Personnel Classifications Volume II, Appendix D (Department of the Navy 2015).

Table 8. All-STEM Degrees Defined

Aerospace, Aeronautical, Astronautical Engineering	Industrial Engineering
Agricultural/Biological Engineering & Bioengineering	Manufacturing Engineering
Architectural Engineering/ Architectural Engineering Technologies	Materials Engineering
Astrophysics	Mathematics
Biochemistry, Biophysics & Molecular Biology	Mechanical Engineering
Biomathematics & Bioinformatics	Metallurgical Engineering
Biomedical/Medical Engineering	Microbiological Sciences and Immunology
Biotechnology	Mining & Mineral Engineering
Cell/Cellular Biology & Anatomical Sciences	Naval Architecture & Marine/Naval Engineering
Ceramic Sciences & Engineering	Nuclear & Industrial Radiologic Technology
Chemical Engineering	Nuclear Engineering
Chemistry	Ocean Engineering
Civil Engineering	Oceanography
Computer Engineering	Petroleum Engineering
Computer Programming	Pharmacology & Toxicology
Computer Science/Info. Tech.	Physics
Construction Engineering	Physiology, Pathology & Related Sciences
Electrical Engineering	Polymer/Plastics Engineering
Electronics & Comm. Engineering	Quantitative Economics
Engineering Mechanics	Statistics
Engineering Physics	Systems Engineering
Engineering Science	Textile Sciences & Engineering
General Engineering	
General Science	

Additionally, a *Limited-STEM* variable was created in an attempt to redefine STEM for the purposes of testing whether the definition of the specific majors included in the STEM field make a difference in predicting officer performance. By narrowing the definition to only engineering, math, computer science, and physics degrees, the Navy may be able to better target certain degrees with a history of success in various warfare designators. Table 9 outlines the degrees that are considered relevant to the Navy.

Table 9. Limited-STEM Degrees

Aerospace, Aeronautical, Astronautical Engineering*	Ocean Engineering*
Chemical Engineering*	Systems Engineering*
Electrical Engineering*	Civil Engineering
Mathematics	Ordnance Engineering
Mechanical Engineering*	Computer Science
Naval Architecture & Marine/Naval Engineering*	Physics
Nuclear Engineering*	
*Engineering programs of Navy interest for NROTC applicants (http://www.nrotc.navy.mil/scholarship_criteria.aspx)	

Included in the education section of the independent variables are rankings for the colleges that junior officers attended. The rankings are based on Barron's *Profiles of American Colleges,* which ranks the competitiveness of the colleges attended. The rankings are binary variables based on six categories of competitiveness and range from "Most Competitive" to "Non Competitive." These six categories were condensed into three categories as depicted in Table 10. The Naval Academy was left out of the Most Competitive category to prevent double counting. Examining the college quality of officers will provide the Navy with a clearer picture into the return on investment of higher quality education. By testing the college quality of officers in relation to the dependent variables, the Navy can better understand if investment in more selective colleges produces a higher quality officer. Moreover, examining the effect of college quality may determine that there is no difference between selective colleges and less selective colleges. This may also apply to STEM degrees from differently ranked colleges where not all STEM degrees are created equal. Table 10 displays the composition of each university competitiveness level.

Table 10. University Competitiveness Variable Composition

Variable	**University Selectivity**
University Competitiveness High	Most Competitive
University Competitiveness Medium	Highly Competitive
	Very Competitive
University Competitiveness Low	Competitive
	Less Competitive
	Non Competitive

b. Navy Community

The Navy Community variables are used to examine the effects of STEM degrees on specific Navy designators. A community such as the Submarine community values officers with STEM degrees whereas some Staff communities do not. Additionally, some communities such as the Engineering Duty Officer community require STEM backgrounds. This thesis uses a variable to examine the effects of STEM degrees on technical Staff and Restricted Line designators. The communities included in the Staff/RL technical variable are Engineering Duty Officers, Aerospace Engineering Duty Officers, Information Dominance Corps Officers, and Civil Engineering Corps Officers. Due to the relatively small size of these communities, they are combined into one variable.

The separation of Unrestricted Line Officers and Restricted Line/Staff Officers will allow this thesis to better understand job fit regarding STEM degrees. The RL and Staff communities are very diverse but by testing the effects of having a technical designator this thesis will provide a deeper understanding into how STEM degrees are used in communities other than Unrestricted Line communities. Previous research has investigated the difference between the URL and RL/Staff communities but has not looked at how technical RL/Staff designators compare to non-technical RL/Staff designators

B. FITREP DATA SET ANALYSIS

A second analysis data set was provided by the Navy that included FITREP data. However, this data set contained FITREP information on only 8,552 officers who were commissioned in the same cohort years as the full data set. The FITREP information was used for the purpose of examining the effect of a STEM degree on officer performance. For the purposes of this thesis, the performance metric is defined by the number of Early Promotion (EP) recommendations received at a given point in an officer's career. In this data there is a fairly even distribution of officers with STEM degrees across the cohorts. Each of the five years in the data set has a fairly even distribution of officers with an *All-STEM* degree and an even distribution of officers with the more restrictive *Limited-STEM* degree definition. Similar to the previous data set, officers with *All-STEM* degrees represent a little over half of the officers in the data set. As expected, officers with the more narrowly defined *Limited-STEM* variable represent a significantly smaller portion of the observations.

Table 11. STEM Distribution by Cohort in FITREP Data Set

Cohort (Fiscal Year)	Number of Observations	All-STEM	Limited-STEM
1999	1,712	966	494
2000	1,815	972	506
2001	1,841	984	530
2002	1,642	917	522
2003	1,542	911	504
Total Observations	8,552	4,750	2,556

Table 11 shows a fairly even distribution of officers with STEM majors in each cohort. The FITREP data set is also representative of the full data set. A little over half of the officers in the analysis data that includes FITREPs have a major considered STEM. Additionally, Table 11 shows that the number of officers with the more narrowly defined and Navy oriented STEM degree definition make up nearly one fourth of the analysis data set.

1. Dependent Variable Descriptions for FITREP Data Set

This thesis uses FITREP data to measure officer performance based on the percent of Early Promotion recommendations received over the course of a 72-month period and over a 120-month period. A commanding officer has a limited number of Early Promotion recommendations that they can give out on a set of FITREPs. Due to the constrained nature of this FITREP assessment metric, a commanding officer will give only his top performers an Early Promotion recommendation. By assessing the percent of Early Promotion (EP) recommendations a pattern of consistent high-level performance can be measured quantitatively. Table 12 provides the dependent variable descriptions.

Table 12. Dependent Variable Descriptions for FITREP Data Set

Variable	**Definition**
Percent of EP's at 72 Months	= the number of EPs in first 72 months of service / the number of FITREPs in first 72 months of service
Percent of EP's at 120 Months	= the number of EPs in first 120 months of service / the number of FITREPs in first 120 months of service

a. Percent of Early Promotion Recommendations

Superior performance is determined by the number of early promotion (EP) recommendations a junior officer receives in their first six years of commissioned service and in their first ten years of commissioned service. These definitions are in line with MSR retention and ten year retention. Due to the varying amount of FITREPs an officer may accumulate over the course of six or ten years, the best way to assess Early Promotion recommendations is via the percentage. The variables *Percent of EPs at 72 months* and *Percent of EPs at 120 months* are continuous variables.

2. Independent Variable Descriptions for FITREP Data Set

The independent variables are the same for both data sets in this thesis. The summary statistics in this section show an overview of the most relevant independent variables. They examine the means of the independent variables across STEM, Unrestricted Line (URL), and Restricted Line (RL) and Staff officer groups. A more comprehensive set of summary statistics relating to officers with backgrounds in STEM can be found in Appendix A.

C. SUMMARY STATISTICS

The summary statistics in this section show an overview of the most relevant independent variables. They examine the means of the independent variables across STEM, Unrestricted Line (URL), and Restricted Line (RL) and Staff officer groups. An additional set of summary statistics relating to officers with backgrounds in STEM can be found in Appendix A.

1. Full Data Set Means

Tables 13 and 14 show the means of all dependent and independent variables used in the full sample, among Unrestricted Line officers and among Restricted Line/Staff officers.

Table 13. Full Data Set Means by Community

Variables	Full Sample Means (n=16,143)	URL Means (n=12,225)	RL/Staff Means (n=3,918)
Career Outcomes			
MSR Retention	0.740	0.752	0.700
Ten Year Retention	0.530	0.515	0.580
O4 Promotion	0.420	0.393	0.504
Independent Variables			
Demographics			
Female	0.184	0.138	0.327
Male	0.816	0.862	0.673
Dependent Children at 2YOS	0.239	0.197	0.371
No Dependent Children at 2YOS	0.761	0.803	0.629
Black	0.071	0.062	0.099
White	0.753	0.759	0.733
Asian	0.051	0.043	0.073
Hispanic	0.094	0.105	0.061
Unknown Race	0.032	0.031	0.034
Married	0.181	0.145	0.296
Not Married	0.819	0.855	0.704
Commissioning Details			
Prior Enlisted	0.210	0.213	0.201
Naval Academy	0.240	0.302	0.046
ROTC	0.265	0.317	0.104
OCS	0.324	0.287	0.439
Direct	0.078	0.005	0.306
Other Commissioning	0.071	0.068	0.083

Table 14. Full Data Set Means by Community (Continued)

Variables	Full Sample Means (n=16,143)	URL Means (n=12,225)	RL/Staff Means (n=3,918)
Education			
All-STEM	0.457	0.456	0.461
Limited-STEM	0.244	0.270	0.160
Graduate Education	0.368	0.354	0.413
University Competitiveness High	0.137	0.144	0.113
University Competitiveness Medium	0.244	0.236	0.267
University Competitiveness Low	0.231	0.198	0.335
Navy Community			
SWO	0.233	0.307	0.000
SUB	0.098	0.129	0.000
Aviator	0.285	0.376	0.000
Special Operations	0.017	0.022	0.000
Restricted Line (RL)	0.059	0.000	0.243
Staff	0.184	0.000	0.757
Unrestricted Line (URL)	0.757		0.000
RL/Staff	0.243	0.000	
Non-Technical RL/ Staff	0.209	0.000	0.861
Technical RL/Staff	0.033	0.000	0.139
Cohorts			
Cohort FY99	0.183	0.181	0.192
Cohort FY00	0.208	0.206	0.214
Cohort FY01	0.211	0.207	0.224
Cohort FY02	0.206	0.208	0.198
Cohort FY03	0.192	0.199	0.172

2. FITREP Data Set Means

Tables 15, 16, and 17 show the means of all dependent and independent variables used in the FITREP sample, among Unrestricted Line officers and among Restricted Line/Staff officers.

Table 15. FITREP Data Set Means by Community

Dependent Variables (8,552 Observations)			
Variables	**FITREP Data Sample Mean (n=7,487)**	**URL Means (n=5,189)**	**RL/Staff Means (n=2,298)**
Percent EP at 72 MOS	0.181	0.189	0.164
Variables	**FITREP Data Sample Mean (n=6,386)**	**URL Means (n=4,351)**	**RL/Staff Means (n=2,035)**
Percent EP at 120 MOS	0.394	0.398	0.385
Independent Variables			
Variables	**FITREP Data Sample Means (n=8,552)**	**URL Means (n=5,636)**	**RL/Staff Means (n=2,916)**
Demographics			
Female	0.197	0.114	0.356
Male	0.803	0.886	0.644
Dependent Children At 2YOS	0.293	0.235	0.406
No Dependent Children at 2YOS	0.707	0.765	0.594
Black	0.084	0.072	0.108
White	0.742	0.751	0.726
Asian	0.054	0.043	0.077
Hispanic	0.088	0.104	0.056
Unknown Race	0.032	0.031	0.034
Married	0.214	0.169	0.302
Not Married	0.786	0.831	0.698

Table 16. FITREP Data Set Means by Community (Continued)

Independent Variables			
Variables	**FITREP Data Sample Means (n=8,552)**	**URL Means (n=5,636)**	**RL/Staff Means (n=2,916)**
Commissioning Details			
Prior Enlisted	0.372	0.322	0.468
Naval Academy	0.216	0.309	0.036
ROTC	0.236	0.294	0.125
OCS	0.324	0.315	0.341
Direct	0.136	0.007	0.384
Other Commissioning	0.069	0.058	0.089
Education			
All-STEM	0.555	0.572	0.524
Limited-STEM	0.299	0.372	0.157
Graduate Education	0.675	0.747	0.538
University Competitiveness High	0.142	0.147	0.130
University Competitiveness Medium	0.309	0.316	0.297
University Competitiveness Low	0.317	0.282	0.386

Table 17. FITREP Data Set Means by Community (Continued)

Independent Variables			
Variables	FITREP Data Sample Means (n=8,552)	URL Means (n=5,636)	RL/Staff Means (n=2,916)
Navy Community			
SWO	0.219	0.332	0.000
SUB	0.102	0.154	0.000
Aviator	0.211	0.320	0.000
Special Operations	0.011	0.017	0.000
Restricted Line (RL)	0.058	0.000	0.170
Staff	0.283	0.000	0.830
Unrestricted Line (URL)	0.659		0.000
RL/Staff	0.341	0.000	
Non-Technical RL/ Staff	0.303	0.000	0.888
Technical RL/Staff	0.038	0.000	0.112
Cohorts			
Cohort FY99	0.200	0.197	0.206
Cohort FY00	0.212	0.209	0.218
Cohort FY01	0.215	0.210	0.226
Cohort FY02	0.192	0.197	0.182
Cohort FY03	0.180	0.187	0.167

3. Dependent Variables for Full Data Set

As previously mentioned, MSR Retention signifies that an officer served beyond their obligated service. In this thesis, MSR retention equals 1 if the officer has served 72 months or more and 0 otherwise. Table 18 shows that over 80 percent of junior officers with a STEM degree retained beyond their MSR. On the other hand, only 68 percent of officers with a degree in something other than STEM stayed beyond MSR. The t-test indicates this difference is statistically significant. Table 19 shows that URL and RL/Staff officers retain beyond their MSR are nearly the same rate.

Table 18. MSR Retention for All-STEM vs. Non-All-STEM Officers

Variable	**MSR Retention Mean (SE)**	**T-Statistics**
All-STEM	.806 (.005)	-17.90***
Non-All-STEM	.683 (.004)	
*** Statistically significant at the 99.9% confidence level		

Table 19. MSR Retention Means for URL vs. RL/Staff Officers

Variable	**MSR Retention Mean (SE)**	**T-Statistics**
URL	.755 (.004)	0.62
RL/Staff	.759 (.004)	
*** Statistically significant at the 99.9% confidence level		

Ten-year retention is defined by an officer serving 120 months or more. Based on Table 20 officers with an *All-STEM* degree that have retained beyond their MSR have a higher rate of staying for ten years or more compared to the officers who do not have an ALL-STEM degree. This difference is statistically significant. Regarding URL officers and RL/Staff officers, Table 21 shows that URL officers have a significantly lower rate of retention to the 10-year mark in comparison to RL/Staff officers.

Table 20. Ten Year Retention Means for All-STEM vs. Non-All-STEM Officers

Variable	**Ten Year Retention Mean (SE)**	**T-Statistics**
All-STEM	.753 (.006)	-8.54***
Non-All-STEM	.682 (.006)	
*** Statistically significant at the 99.9% confidence level		

Table 21. Ten Year Retention Models for URL vs. RL/Staff Officers

Variable	Ten Year Retention Mean (SE)	T-Statistics
URL	.684 (.005)	14.93***
RL/Staff	.829 (.007)	
*** Statistically significant at the 99.9% confidence level		

Table 22 shows that *All-STEM* officers are promoted to O-4 at a significantly higher rate than non-*All-STEM* officers. Nearly 80 percent of *All-STEM* officers who reached at least ten years of service promoted to O-4, whereas only 74 percent of Non-*All-STEM* officers are promoted to O-4.

Table 23 shows that RL/Staff officers are promoted to O-4 at a significantly lower rate than are URL officers.

Table 22. O-4 Promotion Means for All-STEM vs. Non-All-STEM Officers

Variable	O-4 Promotion Mean (SE)	T-Statistics
All-STEM	.799 (.006)	-6.40***
Non-All-STEM	.741 (.007)	
*** Statistically significant at the 99.9% confidence level		

Table 23. O-4 Promotion Means for URL vs. RL/Staff Officers

Variable	O-4 Promotion Mean (SE)	T-Statistics
URL	.752 (.005)	7.10***
RL/Staff	.825 (.008)	
*** Statistically significant at the 99.9% confidence level		

4. Dependent Variables for FITREP Data Set

In Table 24, using the FITREP Data Set and assessing *All-STEM* degrees, on average, 17.4 percent of junior officers who reach 72 months of service receive Early Promotion recommendations. This percentage is lower than the 19.1 percent received by non-STEM officers. This difference is statistically significant.

In Table 25, the means EP percentage at 120 months is higher than the EP percentage received at 72 months. In Table 25, while 38.4 percent of STEM officers received EP recommendations after 120 months of service, non-STEM officers received the EP on 40.8 percent of their FITREPS. This difference is statistically significant.

Table 24. Percent of EPs at 72 Months of Service Means

Variable	**Observations (n= 8,552)**	**Full Sample Mean (SE)**	**All-STEM Mean (SE) (n=4,252)**	**Non-All-STEM Mean (SE) (n=3,235)**	**T-Statistics**
Percent of EPs at 72 Months	7,487	.181 (.002)	.174 (.002)	.191 (.003)	4.57***
*** Statistically significant at the 99.9% confidence level					

Table 25. Percent of EPs at 120 Months of Service Means

Variable	**Observations (n= 8,552)**	**Full Sample Mean (SE)**	**All-STEM Mean (SE) (n=3,663)**	**Non-All-STEM Mean (SE) (n=2,723)**	**T-Statistics**
Percent of EPs at 120 Months	6,386	.394 (.002)	.384 (.003)	.408 (.003)	5.88***
*** Statistically significant at the 99.9% confidence level					

5. Independent Navy Community Variables for Full Data Set

The following tables examine the rate of *All-STEM* degrees across the Surface Warfare Community and Submarine Community in the full data set. These are the communities identified as the most likely to utilize a STEM degree.

a. SWO Community

As Table 26 shows, although the Surface Warfare community prizes STEM degrees, in the full data set only 39.8 percent of SWO officers have a background in *All-STEM* compared to 47.4 percent for non-SWO officers. The t-test indicates this difference is statistically significant.

Table 26. SWO Mean in Full Data Set

Variable	Full Sample Mean (SE) (n=16,143)	SWO Mean (SE) (n=3,759)	Non-SWO Mean (SE) (n=12,384)	T-Statistics
All-STEM	.457 (.004)	.398 (.008)	.474 (.004)	8.3***
*** Statistically significant at the 99.9% confidence level				

b. SUB Community

As expected, in Table 27 the Submariner community has a higher rate of *All-STEM* officers than non-submarine officers – 61.8 percent vs. 43.9 percent. This difference is highly significant.

Table 27. SUB Mean in Full Data Set

Variable	Full Sample Mean (SE) (n=16,143)	SUB Mean (SE) (n=1,575)	Non-SUB Mean (SE) (n=14,568)	T-Statistics
All-STEM	.457 (.004)	.618 (.012)	.439 (.004)	-13.6***
*** Statistically significant at the 99.9% confidence level				

6. Independent Navy Community Variables in FITREP Data Set

Tables 28 and 29 examine the rate of *All-STEM* degrees across the Surface Warfare Community and Submarine Community in the smaller FITREP data set. These are the communities identified as the most likely to utilize a STEM degree.

a. SWO Community

Table 28 shows that in the FITREP data set (n=8,552) 50.4 percent of the Surface Warfare officers have degrees in an *All-STEM* field compared to 57.0 percent in non-SWO communities.

Table 28. SWO Mean in FITREP Data Set

Variable	FITREP Sample Mean (SE) (n=8,552)	SWO Mean (SE) (n=1,871)	Non-SWO Mean (SE) (n=6,681)	T-Statistics
All-STEM	.555 (.005)	.504 (.011)	.570 (.006)	5.1***
*** Statistically significant at the 99.9% confidence level				

b. SUB Community

In Table 29, in the FITREP data set the proportion of *All-STEM* degrees in the Submarine community is well above non-SUB communities – 74.3 percent versus 53.4 percent.

Table 29. SUB Mean in FITREP Data Set

Variable	FITREP Sample Mean (SE) (n=8,552)	SUB Mean (SE) (n=869)	Non-SUB Mean (SE) (n=7,683)	T-Statistics
All-STEM	.555 (.005)	.743 (.015)	.534 (.006)	-11.9***
*** Statistically significant at the 99.9% confidence level				

V. ANALYSIS AND RESULTS

A. METHODOLOGY

This thesis uses five models to examine the effects of a STEM degree on officer performance. The models examine five career outcomes: MSR Retention, Ten Year Retention, O-4 Promotion, and superior performance at the 6-, and 10-year marks. The variables for MSR Retention, Ten Year retention, and O-4 Promotion are binary. When the dependent variable is binary, the thesis employs probit estimating models and reports the marginal effects of the independent variables. Marginal effects measure the effect of a one-unit change in each independent variable on the change in the probability of the dependent (outcome) variable. To test the impact of the continuous variables, the percentage of fitness reports receiving an early promotion (EP) recommendation, the thesis estimates Ordinary Least Squares (OLS) regressions.

B. MODEL SPECIFICATION

1. Minimum Service Requirement Retention Model

This thesis uses a binary variable to measure MSR retention: MSR Retention =1 if the junior officer completes at least six years of service and = 0 otherwise. The MSR Retention outcome is estimated separately for Unrestricted Line (URL) officers and for Restricted Line (RL)/Staff Officers. The *All-STEM* variable used in the main results presented in this section is a broad definition that encompasses the 46 college majors included in the NROTC Tier 1 and Tier 2 majors (see earlier discussion). However, all of the models also are estimated with an alternative, narrower measure of STEM degrees based on only the 13 majors included in the NROTC Tier 1 category. This alternative definition is named *Limited-STEM*. The presumption is that these majors are the most likely to be relevant to the Navy operating environment (see discussion in pages 36–37). The results of the models using the narrower *Limited-STEM* definition are presented in Appendix B but the following discussion below compares the results using the broader *All-STEM* definition to the results using the narrower *Limited-STEM* definition.

The comparison groups for the URL model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *SWO*, *OCS*, and *University Competitiveness Medium*. The MSR Retention model omits aviators from the sample in order to prevent upward bias because their MSR is greater than six years.

Table 30 shows that the mean probability of MSR Retention for Unrestricted Line Officers is 0.68 and is 0.70 for Restricted Line/Staff officers. In the URL model, *Female* and *NROTC* have statistically significant negative effects of -0.017 percentage points (ppts) and -0.127 ppts, respectively. Evaluating these effects at the sample mean retention rate, these coefficients imply that female URL officers are 2.5 percent less likely to stay beyond the MSR point than are males and URL officers commissioned via NROTC are 18.4 percent less likely to stay beyond their MSR compared to OCS graduates.

On the other hand, in the URL model *Dependent Children at 2 YOS*, *Married*, *Prior Enlisted*, *All-STEM*, *University Competitiveness Low*, *SUB*, and *SPEC* all have positive and significant effects on MSR Retention. Officers with an *All-STEM* degree are 19.7 percent more likely to retain beyond MSR than officers without an *All-STEM* degree. Additionally, officers who commissioned from a university with a low competitive level are 24.1 percent more likely to retain past their MSR in comparison to officers commissioned from a medium competitive university.

In the RL/Staff model, the comparison groups for the RL/Staff model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *Non-Technical RL/ Staff designator*, *OCS*, and *University Competitiveness Medium*. The designators included in the technical RL/Staff variable include Engineering Duty Officers, Aerospace Engineering Duty Officers, Information Dominance Corps Officers, and Civil Engineering Corps Officers. Similar to the results for URL officers, the results in Table 30 show that female and officers who enter via NROTC have statistically significant negative effects on MSR Retention. Additionally, in the RL/Staff model, officers in a technical RL or Staff designator have retention rates that are -0.149 ppts (or about 21.3 percent) lower than in non-technical RL or Staff designators.

In the RL/Staff model, *Dependent Children at 2 YOS*, *Married*, *Prior Enlisted*, *Other Commissioning Source*, *STEM*, *University Competitiveness High*, and *University Competitiveness Low* also reveal significant positive effects on MSR Retention.

The results for MSR Retention using the more restrictive *Limited-STEM* definition, which was explained in Table 9, are displayed in Appendix B. *Limited-STEM* officers experience a slightly higher probability of MSR Retention in the URL community, being 20.6 percent more likely to retain. In the RL/Staff model, *Limited-STEM* officers are 8.6 percent more likely to retain although that is less than the effect of the broader *All-STEM* variable where the difference in MSR Retention was 21.6 percent. In the MSR Retention model, how STEM majors are defined did have an impact on retention probabilities and should be considered an area for further research.

This thesis also examined the effects of an *All-STEM* degree and a *Limited-STEM* degree in the Surface Warfare (SWO) and Submariner (SUB) communities. The results of these community-specific models can be found in Appendix C. In prior research these two communities have been identified as the two communities most likely to utilize a STEM degree (Bowman 1990). An *All-STEM* degree results in a 17.2 percent and 27.9 percent increase in the probability of MSR retention for SWO's and Submariners, respectively. Additionally, using the more restrictive *Limited-STEM* definition, the results indicated a difference in MSR Retention by 21.1 percent and 17.3 percent for SWO's and submariners, respectively.

In both the URL and RL/STAFF communities STEM officers have a higher probability of staying beyond MSR Requirement. This may be due to the fact that for many officers in this data set their MSR ended during the Great Recession (which began in the 2007–2008 period). With worsening job prospects in the civilian labor market, many officers with STEM degrees may have opted to stay in the Navy beyond their MSR and re-evaluate their civilian job prospects later in their careers. Specifically, within the SWO and Submariner communities, MSR retention increases may be due to better job fit or retention bonuses.

Table 30. MSR Retention Probabilities

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	-0.175*** (0.019)	-0.118*** (0.017)
Dependent Children at 2 YOS	0.075*** (0.015)	0.105*** (0.016)
Black	0.038 (0.023)	0.019 (0.026)
Asian	-0.027 (0.030)	0.053* (0.027)
Hispanic	-0.017 (0.024)	0.021 (0.030)
Married	0.074*** (0.018)	0.054*** (0.018)
Prior Enlisted	0.242*** (0.063)	0.120** (0.050)
Naval Academy	0.008 (0.019)	-0.027 (0.037)
ROTC	-0.127*** (0.017)	-0.352*** (0.032)
Direct Commissioning	-0.527** (0.196)	-0.046** (0.020)
Other Commissioning Source	-0.031 (0.062)	0.088*** (0.029)
All-STEM	0.136*** (0.013)	0.151*** (0.017)
University Competitiveness High	0.016 (0.018)	0.114*** (0.020)
University Competitiveness Low	0.166*** (0.015)	0.213*** (0.015)
SUB	0.055*** (0.015)	
Special OPS	0.126*** (0.024)	
Technical RL/Staff Designator		-0.149*** (0.029)
Observed Mean	0.689	0.700
Predicted Mean	0.714	0.737
Observations	5,602	3,918

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

2. Ten Year Retention Model

The Ten Year Retention outcome is measured using a binary variable where *Ten Year Retention* =1 if the junior officer completes ten years of service and =0 otherwise. *Ten Year Retention* is estimated separately for Unrestricted Line (URL) officers and for Restricted Line (RL)/Staff Officers. The comparison groups for the URL model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *SWO*, *OCS*, and *University Competitiveness Medium*. The model only includes officers who stay in the Navy beyond MSR, i.e., those for whom MSR Retention =1. This restriction ensures that officers who did not serve beyond their MSR are not counted again for not serving to ten years. Hence, this model measures retention of officers who stay beyond six years to stay to the 10-year point. Table 31 contains the results of the Ten Year Retention model.

The mean probability of *Ten Year Retention* for URL officers and RL/Staff officers is 0.70 and 0.82, respectively. In the URL model *Female*, *Naval Academy*, *ROTC*, *University Competitiveness High*, and *SUB* all have negative and significant effects on *Ten Year Retention*. In the URL model, women are 15.3 percent (-10.7 ppts) less likely to stay ten years than are men. In comparison to a SWO, a submariner is 23.7 percent (-16.7 ppts) less likely to retain to ten years. URL officers commissioned through ROTC are less likely to stay 10 years by 10 percent (-7.5 ppts) and through the Naval Academy by 13.1 percent (-9.2 ppts).

The probability of staying ten years is higher for *Dependent Children at 2 YOS*, *Married*, *Prior Enlisted*, *All-STEM*, *Graduate Education*, *University Competitiveness Low*, *Special OPS*, and *Aviator*. Special OPS and Aviators are 19.9 percent (14 ppts) and 21.9 percent (15.4 ppts), respectively, more likely to stay ten years than are SWO officers. For URL officers, the probability of retention until at least 10 years is 6.7 percent (4.7 ppts) higher for those with *All-STEM* degrees than for those without an *All-STEM* degree.

The comparison groups for the RL/Staff model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *Non-Technical RL/Staff*, *OCS*, and *University Competitiveness Medium*. In the RL/Staff model, the variables *Female* and

Technical RL/Staff have statistically significant negative effects. The RL/Staff model shows that a female is 9.5 percent (-7.9 ppts) less likely than a male to reach ten years of service. Similar to the MSR Retention model, technical RL and Staff officers are less likely to stay to 10 years of service by 16.1 percent (13.4 ppts) as compared to non-technical RL and Staff officers.

There are positive and significant marginal effects in the RL/Staff Model for the variables *Dependent Children at 2 YOS*, *Direct Commissioning*, *Other Commissioning Source*, *All-STEM*, and *Graduate Education*. The RL/Staff model indicates that an officer with an *All-STEM* degree is 7 percent (5.8 ppts) more likely to stay ten years than a RL/ Staff officer without a STEM degree.

The results of the *Ten Year Retention* URL model using the *Limited-STEM* (for results see Appendix B) variable shows it has a positive and statistically significant impact on *Ten Year Retention*. However, the magnitude of the impact is smaller than for the broader *All-STEM* definition. In the URL model, impact of the narrow *Limited-STEM* definition is only slightly less than that of the impact of the broad *All-STEM* variable. The effect of the narrow*ly-defined Limited-STEM* variable was not statistically significant in the RL/Staff model.

The effects of a STEM degree on *Ten Year Retention* within the SWO and Submariner communities are mostly not significant (see full results in Appendix C). The only exception being that the probability of retention is higher for Submariners with a *Limited-STEM* by 12.3 percent than for those without *Limited-STEM* degrees. Although URL officers with an *All-STEM* degree demonstrate positive and statistically significant results *Ten Year Retention* model, an *All-STEM* degree is not significant in the SWO and Submariner communities. This can be explained by the Aviators accounting for the largest share of URL officers (see results of separate models for Aviators in Appendix C). Officers with an *All-STEM* degree in the Aviation community have a 6.8 percent higher probability of staying at least ten years.

In all the retention models, officers with an *All-STEM* degree retain at higher rates than officers without an *All-STEM* degree where the results are statistically significant. This counters the notion that officers with backgrounds in STEM fields will be more likely to leave the Navy due to the value of their degrees in civilian employment. Officers commissioned between 1999 and 2003 with an *All-STEM* degree have a higher probability of staying beyond MSR (six years of service) and beyond ten years of service. Moreover, officers with the more narrowly defined *Limited-STEM* degree also retained at higher levels than officers without a *Limited-STEM* degree although the effect is smaller than it is for the broad definition of *All-STEM*.

Table 31. Ten Year Retention Probabilities

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	-0.108*** (0.020)	-0.080*** (0.017)
Dependent Children at 2 YOS	0.064*** (0.013)	0.067*** (0.014)
Black	0.031 (0.022)	0.017 (0.020)
Asian	0.023 (0.027)	0.003 (0.022)
Hispanic	0.008 (0.021)	0.020 (0.023)
Married	0.070*** (0.015)	0.021 (0.015)
Prior Enlisted	0.203*** (0.038)	0.026 (0.035)
Naval Academy	-0.092*** (0.018)	-0.026 (0.033)
ROTC	-0.075*** (0.015)	-0.015 (0.027)
Direct Commissioning	0.005 (0.246)	0.054*** (0.014)
Other Commissioning Source	-0.026 (0.023)	0.083*** (0.013)
All-STEM	0.047*** (0.012)	0.058*** (0.015)
Graduate Education	0.388*** (0.010)	0.264*** (0.016)
University Competitiveness High	-0.045*** (0.018)	-0.005 (0.022)
University Competitiveness Low	0.061*** (0.013)	0.013 (0.014)
SUB	-0.167*** (0.020)	
Special OPS	0.140*** (0.019)	
Aviator	0.154*** (.013)	
Technical RL/Staff Designator		-0.134*** (0.030)
Observed Mean	0.704	0.829
Predicted Mean	0.766	0.887
Observations	7,618	2,742

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

3. O-4 Promotion Model

The O-4 Promotion model estimates the probability that an officer is promoted to Lieutenant Commander. The dependent variable for the model is binary: *O-4 Promotion* =1 if the junior officer is promoted to Lieutenant Commander and =0 otherwise. The *O-4 Promotion* outcome is estimated separately for Unrestricted Line (URL) officers and for Restricted Line (RL)/Staff Officers. The comparison groups for the URL model is *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *SWO*, *OCS*, and *University Competitiveness Medium*. The model only includes officers who stayed in the Navy for ten years to reach the O4 promotion review. Table 32 contains the results for the O-4 Promotion model.

The mean probability of *O-4 Promotion* for URL officers and RL/Staff officers is 0.72 and 0.82, respectively. In comparison to males, the probability of a woman promoting to O-4 in the URL model is 7.5 percent (-5.5 ppts) below that of a man. In the URL model, the more restrictive *Limited-STEM* variable has a positive and statistically significant effect on O-4 promotion. The probability of promotion to O-4 is 5.3 percent higher than for non-*Limited-STEM* officers (which is comparable to the 4.7 percent difference using the broader *All-STEM* variable).

In the URL model, promotion to O-4 was positively and significantly affected by the variables *Married*, *All-STEM*, *Graduate Education* and *Special OPS*. The probability of promotion to O-4 for an URL officer with an *All-STEM* degree was 4.7 percent (3.4 ppts) higher than for a non-*All-STEM* officer. Additionally, a graduate degree for a URL officer increased the probability of promotion by 29.8 percent (21.7 ppts).

The comparison groups for the RL/Staff model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *Non-Technical RL/Staff*, *OCS*, and *University Competitiveness Medium*. In the RL/Staff model the variables *Black*, *Asian*, *Hispanic*, and *Prior Enlisted* have a negative and statistically significant effect on promotion to O-4. Compared with Whites, the probability of promotion to O-4 in the RL/Staff communities for Blacks, Asians, and Hispanics decreased by 11.4 percent (-9.4 ppts), 10.2 percent (-8.4 ppts), and 7 percent (-5.8 ppts), respectively. In the RL/Staff model the variables *ROTC* and *Graduate Education* have a positive and statistically significant effect on promotion to O-4. The probability of promotion to O-4 for ROTC officers was 14.1 percent (11.6 ppts) higher than for OCS commissioned officers in the RL/Staff model. In the RL/Staff model, the probability of an officer with a *Limited-STEM* degree promoting to O-4 decreased by 7.8 percent.

The effects of a STEM degree on *O-4 Promotion* within the SWO and Submariner communities are mostly not significant. The only except being that the probability of O-4 Promotion is 4.8 percent higher for SWO's with an *All-STEM* degree than for those without an *All-STEM* degree.

The URL model demonstrates that STEM degrees can have a positive effect on performance through promotion. Again, this is contrary to previous research that found college major had little effect on promotion such as Bowman (1990). In some cases social science degrees outperformed STEM degrees as seen in O'Connell (1998) where officers with a Business/Economics degree had a higher probability of promoting to O-4. O'Connell (1998) found that non-STEM degrees had a positive and significant effect on promotion to O-4 in the RL/Staff community; however, the RL/Staff model used in this thesis finds that a STEM major has no effect on promotion to O-4. However, Bowman (1990), O'Connell (1998) and Mehay and Bowman (2002) created more specific categories of degrees whereas this thesis grouped all science, math, and technical degrees into one STEM variable. Thus, the results here may not be strictly comparable to the prior studies that used dummy variables for multiple college majors.

Table 32. O-4 Promotion Probabilities

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	-0.055** (0.024)	0.015 (0.018)
Dependent Children at 2 YOS	0.003 (0.016)	-0.023 (0.017)
Black	-0.034 (0.026)	-0.094*** (0.030)
Asian	-0.010 (0.033)	-0.084*** (0.034)
Hispanic	-0.022 (0.027)	-0.058* (0.038)
Married	0.031* (0.016)	-0.007 (0.018)
Prior Enlisted	-0.019 (0.048)	-0.083* (0.049)
Naval Academy	-0.022 (0.020)	0.042 (0.036)
ROTC	-0.024 (0.017)	0.116*** (0.019)
Direct Commissioning		0.014 (0.018)
Other Commissioning Source	-0.017 (0.025)	0.002 (0.026)
All-STEM	0.034*** (0.013)	0.012 (0.017)
Graduate Education	0.217*** (0.014)	0.213*** (0.020)
University Competitiveness High	0.005 (0.020)	0.015 (0.026)
University Competiveness Low	-0.007 (0.015)	0.018 (0.017)
SUB	-0.007 (0.023)	
Special OPS	0.126*** (0.026)	
Aviator	-0.005 (0.015)	
Technical RL/Staff		-0.016 (0.026)
Observed Mean	0.729	0.825
Predicted Mean	0.762	0.851
Observations	5,358	2,273

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

4. Superior Performance at 72 Months Model

The performance models in this thesis use Ordinary Least Squares to estimate the effect of a STEM degree on the probability of an officer receiving a recommendation for Early Promotion (EP) on a FITREP during a given career period. These models use a smaller data set due to limited FITREP information. The *Percent of EPs at 72 Months* is calculated by dividing the number of FITREPS with recommendations for Early Promotion by the total number of FITREPS in an officer's first 72 months of service. By using a percentage, the variation in the number of FITREPS accumulated by each officer over a given time can be mitigated and allow for a more fair comparison. Table 33 contains the results of the *Percent of EPs at 72 Months* model.

Similar to the retention and promotion models, the performance model outcomes are estimated separately for Unrestricted Line (URL) officers and for Restricted Line (RL)/Staff officers. The comparison groups for the URL model is *Male, No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *SWO*, *OCS*, and *University Competitiveness Medium*. The *Percent of EPs at 72 Months* model only includes officers who completed at least 72 months of service.

In the URL model, only *All-STEM* has a negative and statistically significant effect on the *Percent of EPs at 72 Months*. Holding all else constant, an *All-STEM* degree decreased the percentage of recommendations for Early Promotion (EP) by -1.1 percent. In the URL model, Percent of EPs at 72 Months of Service was positively and significantly affected by the variables *Direct Commissioning*, *SUB*, and *Aviator*. In comparison to SWO's, Submariners and Aviators have a 3.4 percent and 2 percent, respectively, increased probability of receiving an EP. The variables *Naval Academy* and *Technical RL/Staff* have positive and statistically significant effects on the Percent of EPs at 72 Months of Service in the RL/Staff model.

The comparison groups for the RL/Staff model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *Non-Technical RL/Staff*, *OCS*, and *University Competitiveness Medium*. The variables *Female*, *Black*, *Asian*, *Prior Enlisted*, *ROTC*, *Direct Commissioning*, *Other Commissioning Source*, and *STEM* have negative and statistically significant effects on the *Percent of EPs at 72 Months*. Holding all else constant, females received -1.6 percent fewer recommendations for Early Promotion (EP).

The results for the more restrictive *Limited-STEM* variable are shown in Appendix B. *Limited-STEM* has a negative and statistically significant effect on the *Percent of EPs at 72 Months* in the URL and RL/Staff models. The effect of *Limited-STEM* on the probability of receiving an EP in the first 72 months was reduced by -1.1 percent in the URL model and -2.2 percent in the RL/Staff model. However, negative and statistically significant effect is consistent with the broader *All-STEM* definition.

Within the SWO community, the effect of a STEM degree on the *Percent of EPs at 72 Months* was insignificant. However, within the Submariner community, a broader *All-STEM* degree has a negative and statistically significant effect with a 3 percent decrease in the percent of EPs received during the first 72 months of service. This is consistent with the overall negative trend of *All-STEM* and *Limited-STEM* degrees on the URL community in general.

Examining the first 72 months of service provides a glimpse into a junior officer's performance up until their Minimum Service Requirement. In general, officers with a STEM degree received fewer FITREP's with an Early Promotion (EP) recommendation. This supports Mehay and Bowman (2002) who found that STEM degrees either had no effect on EPs received or had an adverse effect. Moreover, they specifically found that STEM degrees had a negative and significant effect on FITREP performance in the Staff community, which echoes the results of this thesis.

Table 33. Percent of EPs at 72 Months

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	0.004 (0.008)	-0.016** (0.008)
Dependent Children at 2 YOS	-0.001 (0.006)	-0.002 (0.008)
Black	0.007 (0.009)	-0.032*** (0.011)
Asian	0.003 (0.011)	-0.049*** (0.013)
Hispanic	-0.007 (0.009)	-0.010 (0.015)
Married	0.000 (0.006)	0.012 (0.008)
Prior Enlisted	0.003 (0.007)	-0.018** (0.009)
Naval Academy	0.000 (0.007)	0.075*** (0.020)
ROTC	0.006 (0.006)	-0.041*** (0.015)
Direct Commissioning	0.353*** (0.085)	-0.054*** (0.009)
Other Commissioning Source	0.018 (0.010)	-0.037*** (0.013)
All-STEM	-0.011** (0.005)	-0.052*** (0.008)
Graduate Education	0.000 (0.006)	0.024*** (0.008)
University Competitiveness High	0.005 (0.007)	0.017 (0.011)
University Competitiveness Low	0.008 (0.005)	0.005 (0.007)
SUB	0.034*** (0.007)	
Special OPS	-0.027* (0.016)	
Aviator	0.020*** (0.005)	
Technical RL/Staff		0.033*** (0.011)
Constant	0.181*** (0.009)	0.223*** 0.013
Observations	4,274	2,298
*** Statistically significant at the 99.9% confidence level ** Statistically significant at the 95% confidence level * Statistically significant at the 90% confidence level		

5. Superior Performance at 120 Months Model

The outcome of the Percent of Early Promotion (EP) Recommendations at 120 Months of Service is continuous and calculated by dividing the number of FITREPS with recommendations for Early Promotion (EP) by the total number of FITREPS in an officer's first 120 months of service. The *Percent of EPs at 120 Months* outcome is estimated separately for Unrestricted Line (URL) officers and for Restricted Line (RL)/Staff Officers. The comparison groups for the URL model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *SWO*, *OCS*, and *University Competitiveness Medium.* The *Percent of EPs at 120 Months* model only includes officers with at least 120 months of service. The results of the model are contained in Table 34. In the URL model the variables *Prior Enlisted*, *Direct Commissioning*, *Other Commissioning Source*, *University Competitiveness High*, *University Competitiveness Low*, *SUB*, and *Special OPS* have a positive and statistically significant effect on the Percent of EPs at 120 Months of Service.

Similar to the 72 Months of Service URL model, in the 120 Months of Service URL model only *All-STEM* has a negative and statistically significant effect on the outcomes. Holding all else constant, an *All-STEM* degree decreased the percentage of recommendations for Early Promotion (EP) by -1.1 percent.

The comparison groups for the RL/Staff model are *Male*, *No Dependent Children at 2 YOS*, *White*, *Not Married*, *Cohort FY99*, *Non-Technical RL/Staff*, *OCS*, and *University Competitiveness Medium*. The variables *Female*, *Black*, *Asian*, *Prior Enlisted*, *ROTC*, *Direct Commissioning*, *Other Commissioning Source*, and *All-STEM* have negative and statistically significant effects on the percent of EPs at 120 months of service.

The variables *Married*, *Naval Academy*, *Graduate Education*, and *Technical RL/Staff* have positive and statistically significant effects on the *Percent of EPs at 120 Months* in the RL/Staff model. Officers in a technical RL or Staff community are 3.9

percent more likely to receive an EP in comparison to officers in a non-technical RL or Staff community holding all else constant.

The *Limited-STEM* variable is negative and statistically significant in both models. While the results in the URL model between *All-STEM* and *Limited-STEM* are nearly identical, the results between the two variables are different in the RL/Staff model. Holding all else constant, officers with a *Limited-STEM* degree are -4.5 percent less likely to receive a FITREP with a recommendation for Early Promotion (EP). Officers with a *Limited-STEM* degree perform slightly better than officers with the broader *All-STEM* degree in the RL/Staff model.

Within the SWO community, an *All-STEM* degree has a negative and statistically significant effect on the *Percent of EPs at 120 Months*. An *All-STEM* degree results in a 1.4 percent decrease in the percent of EPs received at 120 months of service. Within the Submariner community, a STEM degree, regardless of definition, is not significant regarding the *Percent of EPs at 120 Months*.

Overall, the results of the *Percent of EPs at 120 Months* models are similar to the 72 months of service models. A STEM degree decreased the probability of receiving an EP. These results are consistent with Mehay and Bowman (2002). While STEM degrees increased the probability of retention and promotion, they decreased the percent of EPs received.

Table 34. Percent of EPs at 120 Months

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	0.012 (0.009)	-0.047*** (0.009)
Dependent Children at 2 YOS	0.000 (0.006)	-0.010 (0.008)
Black	0.003 (0.009)	-0.031*** (0.012)
Asian	0.012 (0.012)	-0.047*** (0.014)
Hispanic	0.015 (0.009)	-0.007 (0.016)
Married	0.001 (0.007)	0.017* (0.009)
Prior Enlisted	0.017** (0.007)	-0.019** (0.009)
Naval Academy	0.011 (0.008)	0.087*** (0.021)
ROTC	0.003 (0.007)	-0.055*** (0.016)
Direct Commissioning	0.282*** (0.084)	-0.050*** (0.009)
Other Commissioning Source	0.019* (0.010)	-0.046*** (0.014)
STEM	-0.011** (0.005)	-0.087*** (0.008)
Graduate Education	0.006 (0.007)	0.045*** (0.009)
University Competitiveness High	0.013* (0.007)	0.018 (0.011)
University Competitiveness Low	0.016*** (0.006)	0.005 (0.008)
SUB	0.087*** (0.008)	
Special OPS	0.058*** (0.017)	
Aviator	0.007 (0.006)	
Technical RL/Staff		0.039*** (0.012)
Constant	0.373*** (0.011)	0.439*** (0.014)
Observations	3,610	2,035
*** Statistically significant at the 99.9% confidence level ** Statistically significant at the 95% confidence level * Statistically significant at the 90% confidence level		

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VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The Navy's focus on STEM degrees for newly commissioned officers has been driven by the largely unproven "Rickover" hypothesis. This thesis examined the effects of STEM degrees on the performance and retention of junior officers for selected cohorts of newly commissioned officers. In order to test the effects of STEM degrees on retention the thesis examined the retention of junior officers at six years of service and at ten years of service. The thesis also examined job performance through the proxy variables of promotion to O-4 as well as recommendations for Early Promotion (EP) on FITREPs during the first six and first ten years of service. Moreover, the performance and retention models were re-estimated to determine whether the estimated effects of STEM degrees were sensitive to how STEM was defined. This thesis also examined how demographics, community, and commissioning source affect performance and retention. Finally, the performance and retention of officers with STEM degrees was examined through community specific models.

In general, the results of this thesis are mixed. The results in this thesis can be compared to prior studies that found few differences in promotion between officers with and without STEM degrees. Specifically, the results of this thesis show that a STEM degree can have a significant and positive effect on early career outcomes as evidenced by the higher probability of retention beyond the Minimum Service Requirement (MSR) for STEM officers. Furthermore, a STEM degree increased the probability of an officer staying beyond ten years of service as well as being promoted to O-4. These findings partially refute earlier research findings that STEM has no effect on promotion. The findings also refute the presumption that officers with STEM degrees would be more likely to leave the Navy for more lucrative civilian jobs. An important caveat to include with these results is the occurrence of the Great Recession (2007-2009) that coincided with the MSR dates of three of the cohorts of officers (FY01-FY03) and which may have affected civilian employment opportunities.

On the other hand, the results of this thesis confirm prior research that a STEM degree has a negative and significant effect on performance as measured via FITREPS.

STEM majors may bring technical human capital inherent to their undergraduate degree but may be deficient in the interpersonal skills more likely to be obtained through non-STEM degrees. It is possible that, while technical skills are important to junior officers' jobs, the ability to manage people is a significant factor in the success and failure of a junior officer. Moreover, the importance of interpersonal skills is more likely to be reflected on a FITREP than is the importance of a technical skill set.

Additionally, in the MSR Retention model, how STEM majors are defined did have an impact on retention probabilities and should be considered an area for further research. Defining STEM to align with the technical needs of the Navy in future studies may provide a clearer picture for the Navy into what kinds of degrees it should focus on.

B. RECOMMENDATIONS

Given the mixed nature of the results in support of the Rickover Hypothesis that STEM degree officers make better Navy officers, further research appears to be warranted. Further research would certainly be aided by using a larger and more comprehensive data set that included FITREP data for a larger number of officers in the data set. In addition, future work could analyze different alternative measures of performance, beyond the measures developed here, based on Early Promotion recommendations. Future work could also compare summary trait averages and reporting senior averages. Second, investigating the rates of lateral transfers among STEM officers may also provide an important insight when considering retention rates among officers with a STEM degree. It would also be revealing for future research to focus on how STEM degrees affect Warfare Qualification attainment and influence lateral transfers.

Based on the results of this thesis, we recommend that Navy policies focusing on STEM undergraduate majors remain in place. Due to the difficult nature of STEM degrees, at a minimum, they signal a high level of intelligence. However, due to the results of this thesis, we are unable to definitively state that STEM degrees improve career outcomes across the board. Although a technical background can be beneficial to a junior officer's career, it only represents one characteristic of a larger set of skills that may be required to make a successful career as a junior Navy officer.

APPENDIX A. ADDITIONAL SUMMARY STATISTICS

Table 35. Summary Statistics for Dependent Variables in Full Data Set by All-STEM

Variable	**Observations (n= 16,143)**	**Full Sample Mean (SE)**	**All-STEM Mean (SE)**	**Non-All-STEM (SE)**	**T-Statistics**
MSR Retention	11,938	.740 (.003)	.806 (.005)	.683 (.005)	-17.935***
10 Year Retention	8,563	.530 (.004)	.607 (.006)	.466 (.005)	-18.014***
O-4 Promotion	6,776	.420 (.004)	.494 (.006)	.357 (.005)	-17.810***
*** Statistically significant at the 99.9% confidence level					

Table 36. Summary Statistics for Dependent Variables in Full Data Set by Limited-STEM

Variable	**Observations (n= 16,143)**	**Full Sample Mean (SE)**	**Limited-STEM Mean (SE)**	**Non-Limited-STEM (SE)**	**T-Statistics**
MSR Retention	11,938	.740 (.003)	.827 (.006)	.711 (.004)	-14.421***
10 Year Retention	8,563	.530 (.004)	.626 (.008)	.500 (.005)	-13.928***
O-4 Promotion	6,776	.420 (.004)	.508 (.008)	.392 (.004)	-12.883***
*** Statistically significant at the 99.9% confidence level					

Table 37. Dependent Variables in FITREP Data Set by All-STEM

Variable	**Observations (n= 8,552)**	**Full Sample Mean (SE)**	**All-STEM Mean (SE)**	**Non-All-STEM Mean (SE)**	**T-Statistics**
Percent of EPs at 72 Months	7,487	.181 (.002)	.174 (.002)	.191 (.003)	4.576***
Percent of EPs at 120 Months	6,386	.394 (.002)	.384 (.003)	.408 (.003)	5.883***
*** Statistically significant at the 99.9% confidence level					

Table 38. Dependent Variables in FITREP Data Set by Limited-STEM

Variable	**Observations (n= 8,552)**	**Full Sample Mean (SE)**	**Limited-STEM Mean (SE)**	**Non-Limited-STEM (SE)**	**T-Statistics**
Percent of EPs at 72 Months	7,487	.181 (.002)	.184 (.003)	.180 (.002)	-1.038
Percent of EPs at 120 Months	6,386	.394 (.002)	.397 (.003)	.393 (.002)	-.778
*** Statistically significant at the 99.9% confidence level					

APPENDIX B. EFFECT OF "LIMITED-STEM" ON CAREER OUTCOMES

Table 39. MSR Retention Probabilities for Limited-STEM Variable

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	-0.169*** (0.020)	-0.107*** (0.017)
Dependent Children at 2 YOS	0.076*** (0.015)	0.105*** (0.016)
Black	0.039* (0.023)	0.016 (0.026)
Asian	-0.020 (0.029)	0.060* (0.026)
Hispanic	-0.014 (0.024)	0.016 (0.030)
Married	0.075*** (0.018)	0.056*** (0.018)
Prior Enlisted	0.240*** (0.062)	0.138** (0.049)
Naval Academy	0.024 (0.019)	-0.018 (0.034)
ROTC	-0.108*** (0.017)	-0.261*** (0.030)
Direct Commissioning	-0.539** (0.188)	-0.020 (0.019)
Other Commissioning Source	-0.025 (0.061)	0.092*** (0.027)
Limited-STEM	0.142*** (0.013)	0.059** (0.024)
University Competitiveness High	0.027 (0.018)	0.142*** (0.019)
University Competitiveness Low	0.179*** (0.014)	0.242*** (0.014)
SUB	0.066*** (0.015)	
Special OPS	0.135*** (0.023)	
Technical RL/Staff		-0.094*** (0.030)
Observed Mean	0.689	0.700
Predicted Mean	0.715	0.734
Observations	5,602	3,918

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 40. Ten Year Retention Probabilities for Limited-STEM Variable

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	-0.107*** (0.020)	-0.073*** (0.017)
Dependent Children at 2 YOS	0.064*** (0.013)	0.068*** (0.014)
Black	0.031 (0.022)	0.017 (0.021)
Asian	0.023 (0.027)	0.009 (0.022)
Hispanic	0.008 (0.021)	0.018 (0.024)
Married	0.070*** (0.015)	0.020 (0.015)
Prior Enlisted	0.204*** (0.038)	0.033 (0.034)
Naval Academy	-0.083*** (0.018)	-0.007 (0.030)
ROTC	-0.068*** (0.015)	-0.012 (0.023)
Direct Commissioning	0.006 (0.244)	0.065*** (0.013)
Other Commissioning Source	-0.027 (0.023)	0.084*** (0.013)
Limited-STEM	0.031*** (0.012)	0.019 (0.021)
Graduate Education	0.390*** (0.010)	0.267*** (0.016)
University Competitiveness High	-0.042** (0.017)	0.003 (0.022)
University Competitiveness Low	0.066*** (0.013)	0.026* (0.014)
SUB	-0.157*** (0.020)	
Special OPS	0.141*** (0.019)	
Aviator	0.156*** (.013)	
Technical RL/Staff		-0.109*** (0.032)
Observed Mean	0.704	0.829
Predicted Mean	0.766	0.885
Observations	7,618	2,742

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 41. O-4 Promotion Probabilities for Limited-STEM Variable

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	-0.054** (0.024)	0.012 (0.018)
Dependent Children at 2 YOS	0.002 (0.016)	-0.021 (0.017)
Black	-0.035 (0.026)	-0.010*** (0.030)
Asian	-0.009 (0.033)	-0.080*** (0.034)
Hispanic	-0.021 (0.027)	-0.059* (0.038)
Married	0.031* (0.017)	-0.009 (0.018)
Prior Enlisted	-0.019 (0.048)	-0.080* (0.048)
Naval Academy	-0.021 (0.019)	0.055 (0.033)
ROTC	-0.022 (0.016)	0.117*** (0.018)
Direct Commissioning		0.010 (0.018)
Other Commissioning Source	-0.016 (0.025)	-0.006 (0.027)
Limited-STEM	0.039*** (0.014)	-0.064** (0.020)
Graduate Education	0.216*** (0.014)	0.220*** (0.020)
University Competitiveness High	0.007 (0.020)	0.019 (0.025)
University Competeveness Low	-0.004 (0.015)	0.019 (0.016)
SUB	-0.005 (0.023)	
Special OPS	0.127*** (0.026)	
Aviator	-0.004 (0.015)	
Technical RL/Staff		-0.024 (0.026)
Observed Mean	0.729	0.825
Predicted Mean	0.762	0.851
Observations	5,358	2,273

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 42. Percent EPs at 72 Months of Service for Limited-STEM Variable

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	0.004 (0.008)	-0.021** (0.008)
Dependent Children at 2 YOS	-0.001 (0.006)	-0.003 (0.008)
Black	0.007 (0.009)	-0.030*** (0.011)
Asian	0.002 (0.011)	-0.052*** (0.013)
Hispanic	-0.007 (0.009)	-0.007 (0.015)
Married	0.000 (0.006)	0.012 (0.008)
Prior Enlisted	0.003 (0.007)	-0.014** (0.009)
Naval Academy	0.000 (0.007)	0.061*** (0.020)
ROTC	0.006 (0.006)	-0.064*** (0.014)
Direct Commissioning	0.355*** (0.085)	-0.064*** (0.009)
Other Commissioning Source	0.017* (0.010)	-0.047*** (0.013)
Limited-STEM	-0.011** (0.005)	-0.022* (0.012)
Graduate Education	0.000 (0.006)	0.023*** (0.008)
University Competitiveness High	0.004 (0.007)	0.008 (0.011)
University Competitiveness Low	0.007 (0.005)	-0.003 (0.007)
SUB	0.033*** (0.007)	
Special OPS	-0.028* (0.016)	
Aviator	0.020*** (0.005)	
Technical RL/Staff		0.025* (0.013)
Constant	0.179*** (0.009)	0.211*** (0.013)
Observations	4,274	2,298

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 43. Percent EPs at 120 Months of Service for Limited-STEM Variable

Variables	URL Model (SE)	RL/Staff Model (SE)
Female	0.011 (0.009)	-0.056*** (0.009)
Dependent Children at 2 YOS	0.000 (0.006)	-0.010 (0.009)
Black	0.003 (0.009)	-0.027** (0.012)
Asian	0.012 (0.012)	-0.053*** (0.014)
Hispanic	0.014 (0.009)	-0.001 (0.017)
Married	0.001 (0.007)	0.015* (0.009)
Prior Enlisted	0.017** (0.007)	-0.011 (0.009)
Naval Academy	0.013 (0.008)	0.063*** (0.022)
ROTC	0.003 (0.006)	-0.093*** (0.017)
Direct Commissioning	0.286*** (0.084)	-0.066*** (0.010)
Other Commissioning Source	0.017* (0.010)	-0.065*** (0.014)
Limited-STEM	-0.017*** (0.005)	-0.045*** (0.013)
Graduate Education	0.007 (0.007)	0.045*** (0.009)
University Competitiveness High	0.013* (0.007)	0.003 (0.012)
University Competitiveness Low	0.015*** (0.006)	-0.006 (0.008)
SUB	0.087*** (0.008)	
Special OPS	0.057*** (0.017)	
Aviator	0.007 (0.006)	
Technical RL/Staff		0.033** (0.014)
Constant	0.372*** (0.011)	0.417*** (0.014)
Observations	3,610	2,035

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

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APPENDIX C. COMMUNITY-SPECIFIC RESULTS FOR SWO, SUB, AND RL/STAFF COMMUNITIES

Table 44. MSR Retention Probabilities for SWO

Variables	SWO Model using All-STEM (SE)	SWO Model using Limited-STEM (SE)
Female	-0.180*** (0.019)	-0.175*** (0.019)
Dependent Children at 2 YOS	0.071*** (0.019)	0.071*** (0.019)
Black	0.061** (0.026)	0.061** (0.026)
Asian	-0.003 (0.036)	0.005 (0.035)
Hispanic	-0.006 (0.029)	-0.002 (0.028)
Married	0.074*** (0.025)	0.074*** (0.025)
Prior Enlisted	0.281*** (0.076)	0.281*** (0.075)
Naval Academy	-0.008 (0.027)	-0.005 (0.027)
ROTC	-0.152*** (0.021)	-0.142*** (0.021)
Direct Commissioning	-0.428 (0.249)	-0.442 (0.244)
Other Commissioning Source	-0.042 (0.072)	-0.040 (0.072)
All-STEM	0.111*** (0.016)	
Limited-STEM		0.136*** (0.018)
University Competitiveness High	0.009 (0.022)	0.017 (0.022)
University Competitiveness Low	0.184*** (0.019)	0.192*** (0.018)
Observed Mean	0.646	0.646
Predicted Mean	0.668	0.668
Observations	3,759	3,759

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 45. MSR Retention Probabilities for SUB

Variables	SUB Model using All-STEM (SE)	SUB Model using Limited-STEM (SE)
Dependent Children at 2 YOS	0.080*** (0.026)	0.088*** (0.025)
Black	-0.025 (0.055)	-0.017 (0.053)
Asian	-0.073 (0.056)	-0.063 (0.054)
Hispanic	-0.079* (0.051)	-0.085* (0.052)
Married	0.029 (0.029)	0.039 (0.028)
Prior Enlisted	0.739*** (0.019)	0.723*** (0.019)
Naval Academy	-0.027 (0.029)	0.040 (0.024)
ROTC	-0.099*** (0.033)	-0.058** (0.030)
Other Commissioning Source	-0.131 (0.072)	-0.086 (0.189)
All-STEM	0.215*** (0.026)	
Limited-STEM		0.133*** (0.020)
University Competitiveness High	0.020 (0.033)	0.052 (0.030)
University Competitiveness Low	0.109*** (0.026)	0.153*** (0.021)
Observed Mean	0.770	0.770
Predicted Mean	0.811	0.808
Observations	1,575	1,575

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 46. Ten Year Retention Probabilities for SWO

Variables	SWO Model using All-STEM (SE)	SWO Model using Limited-STEM (SE)
Female	-0.035 (0.026)	-0.035 (0.026)
Dependent Children at 2 YOS	0.062** (0.023)	0.063*** (0.023)
Black	0.017 (0.032)	0.018 (0.032)
Asian	0.028 (0.042)	0.027 (0.043)
Hispanic	0.021 (0.035)	0.020 (0.035)
Married	0.097*** (0.027)	0.097*** (0.027)
Prior Enlisted	0.207** (0.064)	0.206** (0.064)
Naval Academy	-0.254*** (0.040)	-0.251*** (0.040)
ROTC	-0.175*** (0.027)	-0.174*** (0.026)
Other Commissioning Source	-0.061 (0.082)	-0.061 (0.082)
All-STEM	-0.005 (0.021)	
Limited-STEM		-0.020 (0.025)
Graduate Education	0.500*** (0.019)	0.503*** (0.019)
University Competitiveness High	-0.070** (0.031)	-0.070** (0.031)
University Competitiveness Low	0.067*** (0.025)	0.066** (0.025)
Observed Mean	0.680	0.680
Predicted Mean	0.764	0.764
Observations	2,427	2,427

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 47. Ten Year Retention Probabilities for SUB

Variables	SUB Model using All-STEM (SE)	SUB Model using Limited-STEM (SE)
Dependent Children at 2 YOS	0.103** (0.044)	0.103** (0.044)
Black	0.028 (0.080)	0.035 (0.080)
Asian	0.125 (0.080)	0.129 (0.080)
Hispanic	0.033 (0.077)	0.031 (0.077)
Married	0.135*** (0.047)	0.139*** (0.047)
Prior Enlisted	0.149 (0.202)	0.151 (0.203)
Naval Academy	-0.176*** (0.045)	-0.164*** (0.043)
ROTC	-0.081* (0.047)	-0.073 (0.030)
Other Commissioning Source	-0.128 (0.300)	-0.099 (0.304)
All-STEM	0.056 (0.040)	
Limited-STEM		0.063* (0.035)
Graduate Education	0.546*** (0.028)	0.545*** (0.028)
University Competitiveness High	-0.001 (0.056)	0.004 (0.056)
University Competitiveness Low	0.146*** (0.048)	0.154*** (0.046)
Observed Mean	0.514	0.514
Predicted Mean	0.540	0.541
Observations	1,213	1,213

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 48. Ten Year Retention Probabilities for Aviator

Variables	Aviator Model using All-STEM (SE)	Aviator Model using Limited-STEM (SE)
Female	-0.179*** (0.029)	-0.179*** (0.029)
Dependent Children at 2 YOS	0.040** (0.017)	0.039** (0.017)
Black	0.046 (0.034)	0.046 (0.034)
Asian	-0.025 (0.041)	-0.029 (0.041)
Hispanic	0.006 (0.028)	0.006 (0.028)
Married	0.031 (0.018)	0.031 (0.018)
Prior Enlisted	0.182*** (0.041)	0.181*** (0.041)
Naval Academy	0.018 (0.020)	0.029 (0.019)
ROTC	0.001 (0.018)	0.010 (0.017)
Direct	-0.173 (0.345)0	-0.179 (0.346)
Other Commissioning Source	0.027 (0.019)	0.025 (0.019)
All-STEM	0.053*** (0.014)	
Limited-STEM		0.025 (0.015)
Graduate Education	0.257*** (0.012)	0.259*** (0.012)
University Competitiveness High	-0.030 (0.022)	-0.026 (0.022)
University Competitiveness Low	0.033** (0.016)	0.039** (0.016)
Observed Mean	0.777	0.777
Predicted Mean	0.823	0.823
Observations	3,757	3,757

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 49. O-4 Promotion Probabilities for SWO

Variables	SWO Model using All-STEM (SE)	SWO Model using Limited-STEM (SE)
Female	-0.008 (0.027)	0.009 (0.027)
Dependent Children at 2 YOS	-0.021 (0.024)	-0.021 (0.024)
Black	-0.070** (0.034)	-0.073** (0.034)
Asian	-0.012 (0.049)	-0.012 (0.049)
Hispanic	-0.018 (0.040)	-0.019 (0.040)
Married	0.004 (0.027)	0.003 (0.027)
Prior Enlisted	-0.028 (0.062)	-0.026 (0.062)
Naval Academy	-0.042 (0.038)	-0.038 (0.038)
ROTC	-0.071*** (0.027)	-0.068*** (0.027)
Other Commissioning Source	0.039 (0.078)	0.040 (0.078)
All-STEM	0.037* (0.021)	
Limited-STEM		0.028 (0.023)
Graduate Education	0.259*** (0.029)	0.261*** (0.029)
University Competitiveness High	0.031 (0.031)	-0.032 (0.031)
University Competitiveness Low	0.028 (0.024)	0.031 (0.024)
Observed Mean	0.768	0.768
Predicted Mean	0.802	0.802
Observations	1,650	1,650
*** Statistically significant at the 99.9% confidence level ** Statistically significant at the 95% confidence level * Statistically significant at the 90% confidence level		

Table 50. O-4 Promotion Probabilities for SUB

Variables	SUB Model using All-STEM (SE)	SUB Model using Limited-STEM (SE)
Dependent Children at 2 YOS	0.048 (0.043)	0.047 (0.043)
Black	0.026 (0.076)	0.026 (0.076)
Asian	-0.068 (0.091)	-0.071 (0.092)
Hispanic	-0.019 (0.084)	-0.020 (0.085)
Married	-0.004 (0.047)	-0.003 (0.047)
Prior Enlisted	-0.248 (0.171)	-0.252 (0.172)
Naval Academy	-0.053 (0.050)	-0.051 (0.050)
ROTC	-0.064 (0.050)	-0.064 (0.050)
All-STEM	0.007 (0.044)	
Limited-STEM		0.033 (0.036)
Graduate Education	0.269*** (0.044)	0.261*** (0.042)
University Competitiveness High	0.012 (0.055)	0.010 (0.055)
University Competitiveness Low	0.030 (0.041)	0.029 (0.040)
Observed Mean	0.754	0.754
Predicted Mean	0.798	0.798
Observations	621	621
*** Statistically significant at the 99.9% confidence level ** Statistically significant at the 95% confidence level * Statistically significant at the 90% confidence level		

Table 51. Percent of EPs at 72 Months for SWO

Variables	SWO Model using All-STEM (SE)	SWO Model using Limited-STEM (SE)
Female	0.016* (0.009)	0.016* (0.009)
Dependent Children at 2 YOS	0.007 (0.008)	0.008 (0.008)
Black	0.002 (0.010)	0.002 (0.010)
Asian	-0.024 (0.015)	-0.024 (0.015)
Hispanic	-0.010 (0.012)	-0.010 (0.012)
Married	-0.024** (0.009)	-0.024*** (0.009)
Prior Enlisted	-0.008 (0.009)	-0.008 (0.009)
Naval Academy	0.001 (0.012)	0.001 (0.011)
ROTC	-0.005 (0.008)	-0.005 (0.008)
Direct	0.149 (0.130)	0.152 (0.130)
Other Commissioning Source	-0.031 (0.024)	-0.032 (0.024)
All-STEM	-0.009 (0.007)	
Limited-STEM		-0.011 (0.007)
Graduate Education	-0.004 (0.009)	-0.003 (0.009)
University Competitiveness High	0.024** (0.010)	0.024** (0.010)
University Competitiveness Low	0.016** (0.008)	0.015** (0.008)
Constant	0.190*** (0.013)	0.189*** 0.012
Observations	1,633	1,633

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 52. Percent of EPs at 72 Months for SUB

Variables	SUB Model using All-STEM (SE)	SUB Model using Limited-STEM (SE)
Dependent Children at 2 YOS	-0.011 (0.013)	-0.012 (0.013)
Black	-0.016 (0.024)	-0.016 (0.024)
Asian	0.053** (0.025)	0.047* (0.025)
Hispanic	-0.005 (0.024)	-0.002 (0.014)
Married	-0.002 (0.014)	-0.003 (0.014)
Prior Enlisted	0.006 (0.017)	0.007 (0.017)
Naval Academy	0.004 (0.014)	-0.002 (0.014)
ROTC	0.022 (0.014)	0.018 (0.014)
Other Commissioning Source	0.052 (0.074)	0.048 (0.075)
All-STEM	-0.030** (0.013)	
Limited-STEM		-0.009 (0.010)
Graduate Education	0.013 (0.011)	0.008 (0.011)
University Competitiveness High	-0.012 (0.017)	-0.014 (0.017)
University Competitiveness Low	0.005 (0.013)	-0.001 (0.013)
Constant	0.222*** (0.021)	0.210*** 0.020
Observations	834	834
*** Statistically significant at the 99.9% confidence level ** Statistically significant at the 95% confidence level * Statistically significant at the 90% confidence level		

Table 53. Percent of EPs at 120 Months for SWO

Variables	SWO Model using All-STEM (SE)	SWO Model using Limited-STEM (SE)
Female	0.012 (0.011)	0.012 (0.011)
Dependent Children at 2 YOS	0.014 (0.009)	0.014 (0.009)
Black	0.001 (0.012)	0.001 (0.011)
Asian	-0.006 (0.018)	-0.006 (0.018)
Hispanic	0.014 (0.014)	0.014 (0.014)
Married	-0.007 (0.010)	-0.007 (0.010)
Prior Enlisted	0.013 (0.011)	0.014 (0.011)
Naval Academy	0.018 (0.014)	0.017 (0.014)
ROTC	-0.001 (0.010)	-0.002 (0.010)
Direct	0.203 (0.144)	0.205 (0.144)
Other Commissioning Source	-0.007 (0.027)	-0.008 (0.027)
All-STEM	-0.014* (0.008)	
Limited-STEM		-0.013 (0.008)
Graduate Education	0.019 (0.012)	0.020 (0.013)
University Competitiveness High	0.024** (0.012)	0.023** (0.012)
University Competitiveness Low	0.015* (0.009)	0.014 (0.009)
Constant	0.363*** (0.017)	0.360*** 0.017
Observations	1,376	1,376

*** Statistically significant at the 99.9% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

Table 54. Percent of EPs at 120 Months for SUB

Variables	SUB Model using All-STEM (SE)	SUB Model using Limited-STEM (SE)
Dependent Children at 2 YOS	0.009 (0.016)	0.009 (0.016)
Black	-0.041 (0.029)	-0.041 (0.029)
Asian	0.021 (0.031)	0.018 (0.031)
Hispanic	-0.025 (0.030)	-0.023 (0.030)
Married	-0.008 (0.017)	-0.009 (0.017)
Prior Enlisted	0.026 (0.019)	0.028 (0.019)
Naval Academy	0.043** (0.018)	0.042** (0.018)
ROTC	0.025 (0.017)	0.023 (0.017)
Other Commissioning Source	0.051 (0.091)	0.048 (0.091)
All-STEM	-0.023 (0.017)	
Limited-STEM		-0.013 (0.013)
Graduate Education	0.015 (0.015)	0.014 (0.015)
University Competitiveness High	0.020 (0.020)	0.020 (0.020)
University Competitiveness Low	0.026* (0.015)	0.022 (0.014)
Constant	0.431*** (0.026)	0.422*** 0.024
Observations	592	592
*** Statistically significant at the 99.9% confidence level ** Statistically significant at the 95% confidence level * Statistically significant at the 90% confidence level		

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